BITING DIPTERA OF MEDICAL IMPORTANCE IN KANSAS

by

WILLIAM WOOD YOUNG

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INTRODUCTION

The medical importance of dipterous insects was realized with the discovery during the late 1800's that mosquitoes were capable of transmitting malaria to man. Since that time many diseases, such as yellow fever, dengue, filariasis, various forms of encephalitis, tularemia and anaplasmosis, which affect man and other species of animals, have been proved to be transmitted by certain insects of the order Diptera.

Information on the Kansas Diptera of medical importance is scattered, for the most part, throughout various publications. This paper is intended to bring together known and new information on the characterization, bionomics, medical importance, distribution in Kansas and the United States, and the control of the Kansas species of medically important insects. Insects of more medical importance in Kansas are the mosquitoes, horse flies and deer flies, black flies and biting midges.

In characterizing the various insects, a complete description is not given, but the outstanding recognition characters and the most important descriptions are given. The keys for identification and description of various species are a combination of characteristics believed by the writer to be the most valuable, in combination with those taken from various authorities, such as Carpenter and LaCasse (1955), mosquitoes; Philip (1947), Schwardt (1936), Brennan (1935), Hays (1956) and Stone (1938), horse flies and deer flies; Foote and Pratt (1954), biting midges; and Smart (1944) and Nicholson and Mickel (1950), black flies. The bionomics are given for each individual species when available and when sufficiently different, or when it entails specialized control measures. The medical importance is given

where applicable to individual species or groups. A generalized distribution in the United States is given, as reported by various authors in catalogs, monographs and various other publications. The information on the distribution in Kansas was obtained from various publications, specimens in the Kansas State College collection and specimens collected during the last year in light traps and surveys in and around Riley county, conducted by the writer. Despite numerous collection sites throughout the state there were very few medically important Diptera collected. This is probably due to the drought conditions which have been experienced in Kansas during the last four or five years.

The compiling of this information for Kansas will give the epidemiologist, veterinarian, entomologist and zoologist a rather complete summary of information, published and unpublished. In addition, it will provide useful information for students.

REVIEW OF LITERATURE

Kansas Mosquitoes

There are very few published works for Kansas, other than Overman (1906), "Notes on some Mosquitoes of Douglas County"; DeMoss (1937), a thesis entitled "The Biology of the Mosquitoes in Kansas and a Key for their Identification" (partially published in Trans. Kans. Acad. Sci., 1939); and Lungstrom (1950), a thesis entitled "Biological Studies on the Common Pasture Mosquito, Culex tarsalis Coq.". Unpublished data by Beadle (1944) deals with mosquitoes found in certain military areas in Kansas.

Howard (1900), Dyar (1922) and Matheson (1929) published on mosquitoes of the United States and North America. Olson and Keegan (1944b) listed the

species found in and around army installations in Kansas and (1944a) gave new distributional records of mosquitoes in Kansas and surrounding states. There also is a summary of the collection program in the Missouri river basin states (Anonymous, 1951). McNeel and Ferguson (1954) listed 47 species of mosquitoes occurring in Kansas. Carpenter and LaCasse (1955) published a definitive work on the taxonomy, biology, geographical distribution and medical importance of the mosquitoes in the United States with excellent illustrations.

Various other publications which contain limited information on the taxonomy, bionomics, and medical importance of certain species of Kansas mosquitoes are Owen (1937), Rozeboom (1942), Rees (1943), Tate and Gates (1944), King, et al. (1944), Ross (1947), Stage, et al. (1952), Owen and Gerhardt (1957) and Barr (1958).

Kansas Tabanids

Brennan (1935) was one of the first to bring together a monographic study in his publication entitled "Pangoniinae of Nearctic America". In this paper descriptions, comparative notes, remarks, type data, and distributional data are given. Stone (1938) covers essentially the same type of data as Brennan in his publication entitled "The Horseflies of the Subfamily Tabaninae of the Nearctic Region". Philip (1947) in his catalog of the nearctic region has a key to the genera, gives synonomous names and excellent reference to keys and descriptions of species. Philip (1931) and Schwardt (1936) have papers dealing with the biologies and taxonomy of Minnesota and Arkansas species, respectively. A list of species occurring in the Arkansas White-Red river basin is presented (Anonymous, 1955). Hays (1956) in his

synopsis of the Tabanidae of Michigan, gives keys and description to many of the species found in Kansas. Other publications containing certain species of Kansas horse flies are Fairchild (1950), MacCreary (1940) and Fattig (1946).

Kansas Black Flies

The earlier studies on the classification of Simuliidae are summarized by Smart (1945) and, in addition, synonomy, keys to genera and the geographical area in which each species occurs are given.

The first work in Kansas was done by Emery (1913) on the morphology and biology of Simulium vittatum and its distribution in Kansas. Malloch (1914) reviewed the black flies in the United States Museum and Dyar and Shannon (1927) gave keys, descriptions and distribution of the North American black flies. Stains and Knowlton (1943) published on the taxonomic and distribution of the black flies of the western United States, and Nicholson and Mickel (1950) gave keys, descriptions, distribution and synonomy of the black flies in Minnesota. A list of the species occurring in the Arkansas White-Red river basin is also available (Anonymous, 1955).

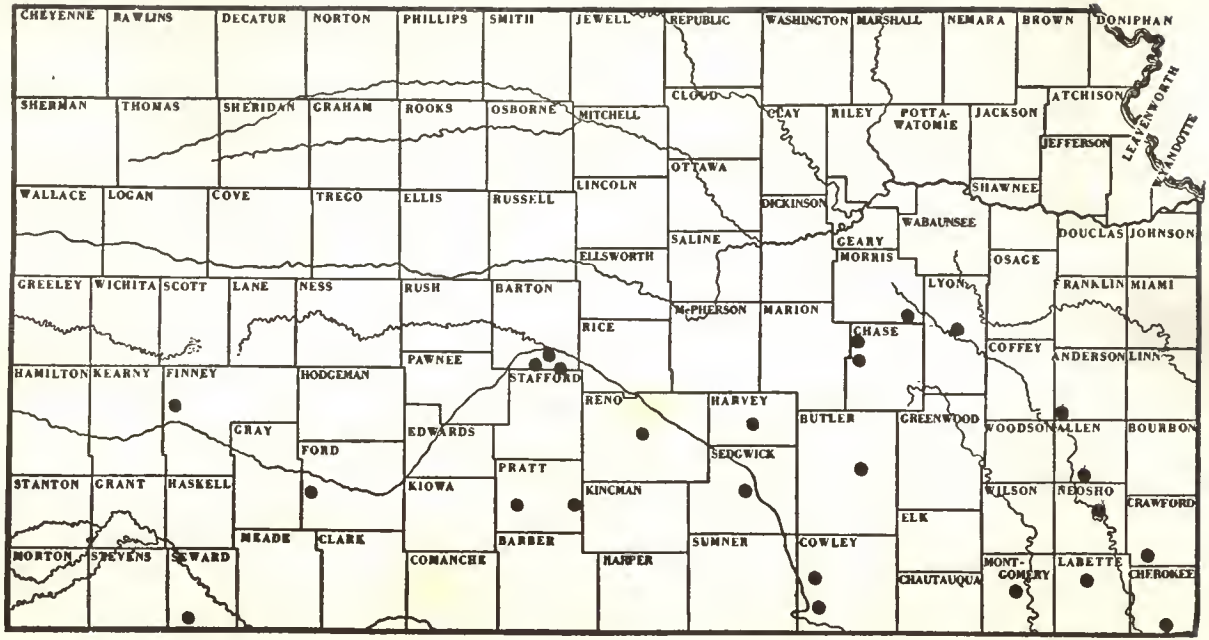
Kansas Biting Midges

The first important work on the species occurring in the United States was done by Malloch (1915). Hoffman (1925) reviewed all previous work on the species occurring in North and Central America. Root and Hoffman (1937) gave additional data on new species, distribution, biology and keys. Johannsen (1943) published a synopsis, taxonomic bibliography and a list of the North American species. Wirth (1952) gives descriptions, keys, and

EXPLANATION OF PLATE I

Location of adult mosquito trap stations in the Arkansas White-Red river basin.

PLATE I


CHEYENNE
RAWLINS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
REPUBLIC
WASHINGTON
MARSHALL
NEMARA
BROWN
DONIPHAN
SHERMAN
THOMAS
SHERIDAN
GRAHAM
ROOKS
OSBORNE
MITCHELL
CLOUD
CLAY
RILEY
POTTA-WATOMIE
JACKSON
ATCHISON
LEAVENWORTH
WYANDOTTE
JEFFERSON
WALLACE
LOGAN
COVE
TREGO
ELLIS
RUSSELL
LINCOLN
OTTAWA
DICKINSON
SHAWNEE
WABAUNSEE
GEARY
SALINE
DOUGLAS
JOHNSON
ELLSWORTH
MORRIS
OSAGE
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
LYON
FRANKLIN
MIAMI
McPHERSON
MARION
RICE
CHASE
COFFEY
HAMILTON
KEARNY
FINNEY
HODGEMAN
PAWNEE
STAFFORD
RENO
HARVEY
ANDERSON
LINN
GRAY
EDWARDS
BUTLER
GREENWOOD
WOODSON
ALLEN
BOURBON
FORD
SEDGWICK
STANTON
GRANT
HASKELL
KIOWA
PRATT
KINGMAN
WILSON
NEOSHO
CRAWFORD
ELK
MEADE
CLARK
BARBER
SUMNER
COWLEY
MORTON
STEVENS
SEWARD
COMANCHE
HARPER
CHAUTAUQUA
MONT-GOMERY
LABETTE
CHEROKEE

figures on the western Culicoidee, and Foote and Pratt (1954) in a monograph entitled "The Culicoidee of the Eastern United States" encompassed the species occurring in Kansas. Wirth and Jones (1957) give the taxonomic differentiation of the variipennis complex of which two subspecies occur in Kansas.

MATERIALS AND METHODS

Previously published and unpublished papers, and identified and unidentified specimens in the insect collection at Kansas State College were the basis for most of the information regarding distribution of the insects discussed. Information on the bionomics, medical importance and the recognition characters was obtained from various publications. The published data on distribution encompasses a large portion of Kansas, the northern section (Anonymous, 1951), the southern section (McNeel and Ferguson, 1954; Anonymous, 1955a; and Beadle, 1944), and the east central section (DeMoes, 1937; Olson and Keegan, 1944a; and Beadle, 1944). A map (Plate I) gives the counties and has the outline of the Arkansas-White-Red River Basin superimposed upon it.

In addition, adult collections were made in and around Riley county. Collections were made by the use of an ultraviolet light trap on the fire escapes of Fairchild Hall at Kansas State College, a portable ultraviolet light trap operated northwest of Manhattan, personal collections and specimens made available by members of the Department of Entomology.

Larval collections were made at various locations in Riley and Pottawatomie counties and brought into the laboratory for determination rearing to adults. The larvae were collected by means of a white enameled

water dipper which had a three-foot wooden dowel inserted in the handle to provide extra length. When collecting the larvae, sufficient water was taken from the larval pool (approximately three-quarters of a pint) and put into a pint jar with the larvae to insure as little change as possible in the water composition.

After being brought into the laboratory the larvae were fed a small pinch of dog chow every few days and the jars were covered with bleached cheesecloth. Approximately twenty-four hours after emergence the adults were killed by placing a cyanide jar, of equal size, over the larval container and as soon as the mosquitoes were knocked down the adults were removed with forceps, placed on paper points or pinned on "minuten nadeln" pins, and then placed in the freezing compartment of a refrigerator for twenty-four hours to insure death. During the course of this study it was suggested by a fellow student to use white shellac to fix the adults to the paper points. This method proved very satisfactory inasmuch as difficulties were experienced in mosquitoes falling off points and the pin sticking from the pleura at the exact point which is needed to see for identification.

The adult tabanids collected were pinned in the regular manner. The black flies were pinned on minuten nadeln pins and sent to the United States National Museum for identification. The adult biting midges were placed in seventy percent alcohol or placed on paper points, and sent to the United States National Museum for identification. The information on some material sent for identification has not yet been received. All material collected by the writer and found in the College collection will be indicated (KSC).

A different type of key was constructed following a block form. All species are listed on the left margin and the principal distinguishing

characteristics are listed under separate headings on the right. This key in some respects is more valuable than the couplet key in that, when the specimen is tentatively identified, it is possible to review the separating characters without having to leaf through several pages and getting lost in the numbering system. It also provides an advantage in that several characters can be evaluated, rather than one, as is often the case with couplet keys.

MOSQUITOES (CULICIDAE, DIPTERA)

Family Culicidae

The adult taxonomic characters which separate the family Culicidae from the other families of Diptera are wing venation, the small rudimentary first segment of the antenna and the enlarged second antennal segment, the completely divided pronotum, the combined prescutum and scutum, and the long legs usually lacking spurs on the tibia. The larvae possess a complete head capsule, have only one pair of functional abdominal spiracles, and are without exception essentially aquatic.

This family consists of three subfamilies, the Dixinae, Chaoborinae and Culicinae.

The Culicinae is the taxon which includes the true mosquitoes and is the only subfamily which is considered to be of medical importance. The subfamily Dixinae is separated from the Culicinae in that the wings are almost devoid of hairs and scales and the proboscis is not fitted for piercing. The subfamily Chaoborinae is separated in that its mouth parts are short and the wings are clothed for the most part with long hairs and the scales are almost confined to the fringe of the wing.

Key to the subfamilies of Culicidae (Diptera).

1 Wings devoid of scales. Mouth parts not fitted for piercing; antennae with a 14 segmented flagellum ..... Dixinae

1' Wings with scales at least on fringes. Antennae with a 13 segmented flagellum 2

2 Wings clothed with hairs, scales almost confined to fringe. Mouth parts short ..... Chaoborinae

2' Wings have scales on veins. Mouth parts fitted for piercing ..... Culicinae

Subfamily Culicinae. This taxon stands out prominently among the species of blood sucking arthropods which annoy man and other warm blooded animals. They are not only pestiferous in nature but are capable of transmitting various diseases of man and animals such as malaria, yellow fever, dengue, encephalitides, filariasis, heart worm and others.

The habitat and breeding habits are varied and extensive. Adults may be found in and around houses, forests, or grasses, some may feed only at dawn, while others feed at dusk or night and some during the day or at any time they are disturbed or have the opportunity to feed. The larvae may be found in various types of water such as salt, fresh, foul or potable. The size of the impounded water may vary from a hoof print to a large reservoir; habitats also include tin cans, flower vases, tree holes, or water impounded in the leaves of trees.

The life history of all mosquitoes is essentially the same inasmuch as they pass through several stages of a complex metamorphosis consisting of egg, larva, pupa and adult. The eggs may be deposited, depending on the species, either singly or in rafts. Those deposited singly may be equipped with floats. The larva or wriggler stage is the feeding stage of the immature mosquito which undergoes four molts, the last molt results in a pupa.

The pupa or tumbler is a non-feeding stage which usually is short in duration, lasting only a few days.

The flight range of the adult is varied. Most mosquitoes remain close to their breeding grounds, usually within one hundred yards if it is far enough to obtain a blood meal. Others will migrate or be carried by the wind at least 50-75 miles according to Herms (1950).

The classification as given by Edwards (1932) divided this subfamily into three tribes, Anophelini, Culicini and Toxorhychitini.

Key to Tribes of the Subfamily Culicinae (Culicidae, Diptera) - Adult Females.

1 Palpi relatively short. Abdomen covered with scales on both dorsal and ventral 2

1' Palpi as long as proboscis. Sternites void of scales for the most part ..... Anophelini

2 Trilobed scutellum. Proboscis of uniform thickness ..... Culicini

2' Rounded scutellum. Proboscis thickened in basal half and curved downward and backward apical half ..... Toxorhychitini

Tribe Anophelini. This tribe contains, according to Edwards (1932), three genera: Chagasia, which is found in tropical America; Bironella, found in New Guinea and adjacent islands; and Anopheles which is practically world-wide in distribution and the only genus found in Kansas.

Genus Anopheles. This genus is divided, using mostly male characteristics, by Edwards (1932) into four subgenera: Anopheles, found throughout the Old and New Worlds; Nyssorhynchus, found principally in Central and South America; Stethomyia, known from Central and South America; and Myzomyia, found throughout the tropical and subtropical regions of the Old World. The subgenus Anopheles is the only one occurring in Kansas.

Subgenus Anopheles. This genus has been of known importance to man since the late 1800's when it was incriminated as the vector of malaria. At one time malaria was considered to be one of the more important diseases of man; now it is virtually gone from the United States and is one of the diseases that through the cooperation of the various countries is being eliminated from the world.

These mosquitoes are characterized by having the palpi about as long as the probosois, the scutellum evenly rounded, mandible and maxillas of the females well developed and toothed, legs very long and slender with no distinct tibial bristles and no pulvilli. The abdomen is without scales and the wings usually have distinct markings. The eggs are characteristic inasmuch as they are laid singly and have so-called floats along the lateral margins. The larvae are easily recognizable in not having a readily discernible air tube and in resting parallel to the surface of the water while members of the other tribes hang down at an angle from the surface. The adult female body is at a forty-five degree angle or greater when feeding.

Key to Genus Anopheles Found in Kansas - Adult Females.

1 Scales on wings entirely dark 2

1' Pale spots on wings 4

2 Scales uniformly dark, legs entirely dark, abdomen clothed with dark setae. Integument of scutum shiny brown and clothed with long dark setae which are at least half as long as width of scutum ..... barberi

2' Scales not uniformly dark; have spots of dark scales 3

3 Palpi with narrow white ring at apex. Haltere knob usually pale scaled. Scales forming 4 more or less distinct spots on wings ..... walkeri

3' Palpi without narrow white ring at apex. Haltere knob dark scaled. Scales forming 4 rather distinct spots on wings ..... quadrimaculatus

4 Pale spot at extreme tip of costa, otherwise dark. A pair of submedian longitudinal stripes on integument ..... crucians

4' Pale spot opposite tip of subcosta 5

5 Wing vein 3 and 5 entirely dark scaled ..... punctipennis

5' Wing vein 3 and 5 dark and pale scaled * pseudopunctipennis pseudopunctipennis

Anopheles barberi Coquillett

Anopheles barberi Coquillett, 1903, Can. Ent., 35:310.

Recognition Characters. The adult female is a small species with the integument of the scutum brown and shiny, clothed with long dark setae at least half as long as the width of the scutum. The abdomen is brown and densely clothed with dark-brown hairs. The legs are dark and the wing scales are dark and slightly broadened.

Bionomics. The larvae are found in rot cavities or "tree holes" of trees of many kinds, in stumpholes and occasionally in artificial containers near wooded areas usually associated with leaves and other plant debris. The adults appear during the latter part of May or the first part of June, and may occasionally be found resting during the day underneath bridges, in culverts and in buildings in or near wooded areas. The female is a persistent biter but seldom finishes a blood meal at one sitting.

Medical Importance. Since this mosquito is very seldom found in large numbers, its medical importance in the transmission of malaria is doubtful, but it is capable of transmitting. (Carpenter and LaCasse, 1955).

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* pseudopunctipennis franciscanus differs from pseudopunctipennis pseudopunctipennis as follows: "Terminal segment of the palpi has the apical part dark-scaled except for a subapical white patch on fork 2.1 and a small patch on stem near the crose vein 2-3; vein 4 has stem predominantly dark-scaled" (Carpenter and LaCasse, 1955).

Distribution. It occurs in eastern United States, north to New York and west to Nebraska and Texas (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Allen, Bourbon, Butler, Cherokee, Cowley, Ellis, Ellsworth, Finney, Geary, Harvey, Johnson, Kingman, Leavenworth, Pratt, Republic, Sheridan, Wilson, and Woodson counties (Anonymous, 1951); Montgomery, Labette, Riley, Sedgwick counties (Beadle, 1944); and from the Arkansas-White-Red river basin (McNeel and Ferguson, 1954).

Anopheles crucians Wiedemann

Anopheles crucians Wiedemann, 1828, Ausser. Zweifl., Ins., 1:12.

Recognition Characters. The adult female is a medium-sized species which is indistinguishable from A. bradleyi and A. georgianus. The scutum has a pair of dark gray submedian longitudinal stripes, and its integument mottled gray, brown, and black. The abdomen is clothed with numerous yellow to dark brown hairs. The legs are dark with the femora and tibiae tipped with white. The wings have white to yellowish-white scales on the veins in contrasting lines and spots.

Bionomics. The larvae are found in ponds, lakes, swamps, and semipermanent pools and generally associated with aquatic vegetation. The adults very seldom enter houses but are principally outdoor biters and attack mostly at night. The body of the female forms an angle of nearly ninety degrees when in the resting position. The adults are readily taken at a light trap.

Medical Importance. It has been found by Sabrosky (1946) to be infected in nature with malaria.

Distribution. It is found in the southeastern United States north to Massachusetts and west to Kansas and New Mexico.

Kansas Distribution. It has been reported from Cowley, Labette, and Montgomery counties (Beadle, 1944); from Allen, Bourbon, Cherokee, Leavenworth and Linn counties (Anonymous, 1951): and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Anopheles pseudopunctipennis franciscanus McCracken

Anopheles franciscanus McCracken, 1904, Ent. News, 15:12. Synonomy: Anopheles boydi Vargas and Anopheles pseudopunctipennis var. willardi Vargas.

Recognition Characters. The adult female is a medium-sized, similar to A. pseudopunctipennis pseudopunctipennis, but has the terminal segments of the palpi apically dark-scaled and wing vein 2 is dark scaled with the exception of 2.1 which has a subapical white patch near cross vein 2-3, and the stem of vein 4 is predominantly dark scaled.

The integument of the scutum which is dark brown laterally has a broad median longitudinal frosted stripe which extends the full length. The stripe is clothed with narrow yellowish-white scales and pale yellow hairs. The abdomen is clothed with golden-brown hairs and the legs are dark with the tips of the femora and tibiae pale. The scales of the wings are black and pale yellow which are arranged in contrasting lines and spots.

Bionomics. The larvae are found in shallow pools along the margins of streams during dry seasons. The female prefers larger mammals such as horses, cows and sheep and rarely attacks man.

Medical Importance. It is not regarded as an important vector of malaria inasmuch as it seldom attacks man.

Distribution. Little is known of its distribution at the present time, but it is known to occur in southwestern United States east to western Texas

and Oklahoma (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported, but as rare, in Finney county (Beadle, 1944); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1944).

Anopheles pseudopunctipennis pseudopunctipennis Theobald

Anopheles pseudopunctipennis Theobald, 1901, Mon. Culic., 2:305. Synonomy: Anopheles peruvianus Tamayo and Garcia, Anopheles argentinus Brethes, and Anopheles tuoumanus Lahille.

Recognition Characters. The adult female is medium-sized with the integument of the scutum having a medium broad frosted stripe and dark brown in color laterally. The frosted area is clothed with narrow yellowish-white scales and pale yellow hairs. The abdomen is clothed with golden brown hairs and the legs are dark with the tips of the femora and tibiae being pale. The scales of the wings are black and pale yellow which are arranged in contrasting lines and spots.

Bionomics. The larvae have been found in drying sunlight pools containing mats of Spirogyra. The adult females may be found in houses in some parts of the country but usually feeds outside on horses, cattle, burrows, and man.

Medical Importance. It is not regarded as being of importance in the United States.

Distribution. The distribution has been confused with A. pseudopunctipennis franciscanus and is not well known but it is known to occur in southern United States (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Riley county by DeMoee (1937); from Cowley, Montgomery, Labette, Riley, Shawnee, and Sedgwick counties (Beadle, 1944); from Allen, Barber, Bourbon, Coffey, Ellis, Ellsworth, Franklin, Meade, Neosho, Pottawatomie, Pratt, Rooks, and Seward counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Anopheles punctipennis (Say)

Culex punctipennis Say, 1823, Jour. Acad. Nat. Sci. Phila., 3:9. Synonomy: Anopheles perplexens Ludlow and Anopheles punctipennis etonei Vargas.

Recognition Characters. The adult female is a medium sized species and the integument of the scutum has a broad median-frosted stripe and dark brown laterally. The frosted stripe is clothed with short pale-yellow hairs, and with larger dark setae on the darker lateral area. The abdomen is clothed with pale and dark hairs, the legs are dark scaled with the femora and tibiae tipped with pale scales. The wing scales are black and pale yellow which are arranged in contrasting lines and spots.

Bionomics. The larvae are found in a large variety of aquatic habitats such as ponds, temporary pools, springs, pools in intermittent streams, borrow pits, roadside puddles, wheel ruts, rain barrels, and other artificial containers. The females attack man mostly at dusk but will feed during the day in dense woodlands or in their daylight resting places which are dark moist shelters.

Medical Importance. It is possible for this species to be infected with malaria in the laboratory but is not considered to be an important vector.

Distribution. It is found throughout most of the United States east of the Rocky Mountains.

Kansas Distribution. It has been reported from Doniphan, Douglas, Pottawatomie, Riley and Saline counties by DeMoss (1937); from Cowley, Montgomery, Labette, Shawnee, Sedgwick (Beadle, 1944); from Allen, Anderson, Barton, Bourbon, Butler, Cherokee, Cloud, Coffey, Crawford, Dickson, Ellis, Ellsworth, Finney, Ford, Geary, Greenwood, Harvey, Johnson, Kingman, Leavenworth, Linn, McPherson, Marion, Morris, Neosho, Phillips, Reno, Republic, Rice, Rush, Seward, Wabaunsee, Wilson and Wyandotte counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Anopheles quadrimaculatus Say

Anopheles quadrimaculatus Say, 1824, Keating's Narr. Exp. St. Peter's River 2:356. Synonomy: Anopheles guttulatus Harris and Anopheles annulimanus Van der Wulp.

Recognition Characters. The adult female is medium sized with the integument of the scutum brown to black and clothed with numerous pale-yellow to golden brown hairs which are more numerous medially and longer laterally. The abdomen is densely clothed with yellowish brown hairs, and the legs are dark scaled with the femora and tibiae tipped with white scales. The wing scales are entirely dark with some of them forming four rather distinct darker spots.

Bionomics. The larvae are found in permanent fresh water and very seldom in pools of a temporary nature. The adult female who feeds mostly after dusk is an active feeder on man and animals.

Medical Importance. It is regarded as the most important vector of malaria in the United States.

Distribution. It is found in eastern and central United States north to southern Canada.

Kansas Distribution. It has been reported from Douglas county by DeMoee (1937); from Cowley, Montgomery, Labette, Riley, Shawnee, and Sedgwick counties (Beadle, 1944); from Allen, Anderson, Barton, Bourbon, Brown, Butler, Chautauqua, Cherokee, Cloud, Crawford, Doniphan, Ellis, Ellsworth, Finney, Franklin, Geary, Greenwood, Harvey, Johnson, Kingman, Kiowa, Leavenworth, Linn, Lyon, Marion, Marshall, Meade, Miami, Morris, Neosho, Osage, Ottawa, Phillips, Pratt, Reno, Republic, Rice, Rooks, Rush, Saline, Stafford, Sumner, Wabaunsee, Wilson, Woodson and Wyandotte counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Anopheles walkeri Theobald

Anopheles walkeri Theobald, 1901, Mon. Culic., 1:299.

Recognition Characters. The adult female is medium sized with the integument of the scutum dark brown to black, clothed with short golden-brown hairs medially and longer dark setae laterally. The abdomen is densely clothed with yellow to brown hairs, and the legs are dark scaled with the femora and tibiae being tipped with pale scales. The wing scales are narrow and dark with some of the scales forming four darker spots more or less distinct.

Bionomics. According to Carpenter and LaCasse (1955) larvae occur in fresh water marshes containing floating vegetation. The adults are known to enter dwellings at night to feed on man and then retreat to their dark,

moist resting places.

Medical Importance. It is probably a potential vector of malaria inasmuch as it may successfully transmit malaria in the laboratory.

Distribution. It is found in eastern United States from the Gulf of Mexico north to southern Canada and west to North Dakota, Nebraska, and Texas.

Kansas Distribution. It has been reported from Allen, Anderson, Bourbon, Johnson, Leavenworth, Linn, and Neosho counties (Anonymous, 1951), and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Tribe Culicini. This tribe contains nine genera in North America, of which seven are represented in Kansas: Aedes, Culiseta, Culex, Mansonia, Orthopodomyia, Psorophora, and Uranotaenia. The two genera which are not represented in Kansas are Deinocerites and Wyeomyia.

Key to Genera of the Culicini (Culicinae, Culicidae, Diptera) in Kansas (Adapted from Carpenter and LaCasse, 1955).

1	Second marginal cell of wing short, less than half as long as its petiole	Uranotaenia
1'	Second marginal cell as long or longer than its petiole	2
2	Spiracular bristles present	3
2'	Spiracular bristles absent	4
3	Postspiracular bristles present; tip of abdomen pointed	Psorophora
3'	Postspiracular bristles absent; tip of abdomen blunt	Culiseta
4	Postspiracular bristles present	5
4'	Postspiracular bristles absent	6
5	Wing scales very broad; tip of abdomen blunt	Mansonia
5'	Wing scales narrow; tip of abdomen pointed	Aedes

6 Wing scales broad and intermixed brown and white ..... Mansonia

6' Wing scales narrow, uniformly dark ..... Culex

Genus Aedes. This genus is divided into five subgenera by using the form of the male palpi and terminalia: Ochlerotatus, Finlaya, Stegomyia, Aedimorphus, and Aedes. Inasmuch as the separation into subgenera is made by using male characteristics, the species found in Kansas are not separated into subgenera.

The members of this genus are important not only from their annoyance by biting, but also because they are capable of transmitting yellow fever and several strains of mosquito-borne encephalitides. The adult female lays her eggs either in the water or near it where it will be flooded at a later date; oviposition may occur in a variety of places including artificial containers, floodwaters, tree holes, rock holes, and numerous other breeding conditions.

The females are characterized by having a progressively tapering abdomen with prominent cerci, the thorax having variable ornamentation, and the lack of postepiracular bristles.

Key to Adult Female Aedes Mosquitoes in Kansas, Adapted from Carpenter and LaCasse (1955).

1 White rings on hind tarsal segments 2

1' Without white rings 12

2 Tarsal segments ringed both apically and basally 3

2' Tarsal segments with only basal rings 5

3 Dark and white scales intermixed on wing ..... dorsalis

3' All wing scales dark or some white scales on anterior vein 4

4 Patch of white scales at base of costa ..... atropalpus

4' Base of costa dark scaled ..... canadensis canadensis

5 White ring near middle of probosois 6

5' Lacking white ring 7

6 First segment of hind tarsus with a yellow medium ring and the latsral markings of ths abdomen white ..... sollicitans

6' First segment of hind tarsus white; lateral markings of abdomen yellowish ..... nigromaculis

7 Conspicuous lyre shaped pattern of silver whits scales on scutum against dark background ..... aegypti

7' Scutum without such markings 8

8 Hind femora pale on all aspects of basal half ..... zoosophus

8' Hind femora not pale, either dark or intermixed scales on basal half 9

9 Basal white rings on tarsal segment narrow ..... vexans

9' Basal whits rings on tarsal segment broad, especially hind tarsi .. 10

10 Palpi all dark ..... nigromaculis

10' Palpi with some pale scalss 11

11 Abdominal tergitss without basal bands and clothed with yellow scales ..... flavescens

11' Abdominal tergitss with pale basal bands and clothed with dark scales ..... stimulans

12 Scutum marked with silvsr whits scales 13

12' Scutum not so marked 15

13 Broad medium stripe of dark brown scales and the sides clothed with silver white scales ..... triseriatus

13' Broad medium stripe of silver scales on the scutum 14

14 Wing length about 2.5 mm; small species ..... dupreei

14' Wing length about 3.5 mm; medium sized speciss ..... atlanticus

15 Scutum marked with a pair of submedian white or yellowish whits stripss separated by a brown stripe of the same width .... trivittatus

15' Scutum not so marked 16

16 Wing scales bicolored ..... spenoerii

16' Wing scales dark or white only at base of vein 17

17 Scutum without contrasting lines or stripes ..... cinereus

17' Scutum with contrasting lines or stripes ..... stictious

Aedes (Stegomyia) aegypti (Linnaeus)

Culex aegypti Linnaeus, 1762, Hass. Pol. Reise, p. 470. Synonomy: Stegomyia fasciatus F., Culex calopus Meig., Culex argenteus Poir., and others according to Dyar (1922) and Edwards (1932).

Recognition Characters. Adults are small to medium sized, dark, with conspicuous rings of white scales on the tarsi and patches of white on the sides of the thorax and abdomen. The most notable characteristic is a lyre-shaped pattern on the mesonotum, formed by lines of white scales.

Bionomics. This species is the most thoroughly domesticated species known. It breeds almost exclusively in artificial containers but is sometimes found in rot cavities of shade trees near residences (Carpenter and LaCasse, 1955). The eggs are deposited generally in artificial containers around dwellings, either just above the water level or on the surface of the water. After a maturation period, usually one to three days, the eggs hatch when they come in contact with the water, and the larvae feed upon suspended or detachable organic matter.

The adult females are wary in feeding, often attacking around the ankles. They usually feed early in the morning or late in the afternoon, but will feed during mid-day in the shade or in lighted rooms at night. Common resting places are in closets, cupboards, cabinets, behind picture frames and doors. The adults seldom fly more than a few hundred feed from the

water container from which they emerged.

Medical Importance. This species is an important vector of yellow fever, dengue and possibly some encephalitis.

Distribution. This species is found throughout most of the tropical and subtropical regions of the world. It occurs in the United States in the southeastern states and sometimes in their bordering states.

Kansas Distribution. It has been reported as occurring in Cowley, Montgomery, Labette, and Sedgwick counties (Beadle 1944); from Cherokee county (Anonymous, 1951); and by McNeel and Ferguson (1954) in the Arkansas-White-Red river basin.

Aedes (Ochlerotatus) atlanticus Dyar and Knab

Aedes atlanticus Dyar and Knab, 1906, Jour. N. Y. Ent. Soc., 14:198.

Recognition Characters. Adults are moderately sized, black, with a broad silvery gray stripe through center of thorax. The abdomen is black, with lateral white scales which partly show on dorsum of the apical segments.

Bionomics. The larvae are found in temporary pools in open fields and in woodlands. The female is a vicious biter and is usually associated with Aedes infirmatus and other woodland species (King, et al., 1944).

Medical Importance. This species is not known to be of medical importance.

Distribution. This species is common in the Gulf States, but occurs in all southeastern states, north to New York and west to Kansas and Texas.

Kansas Distribution. It has been reported as occurring in Labette and Bourbon counties (Anonymous, 1951). It was also reported by McNeel and

Ferguson (1954) in the Arkansas-Red-White river basin.

Aedes (Finlaya) atropalpus (Coquillett)

Culex atropalpus Coquillett, 1902, Can. Ent., 34:392. Synonomy: Aedes epactius Dyar and Knab and Aedes pericharee Dyar (Carpenter and LaCasse, 1955).

Recognition Characters. Two races have been recognized by Dyar (1922), atropalpus atropalpus found in the Atlantic States, and atropalpus epactius from Arizona and Mexico. The latter has the mesonotal light markings white instead of golden yellow.

The adults are small to medium sized, with a broad median stripe of fine dark brown scales and yellowish-white scales laterally, on the mesonotum. The abdomen is dark scaled, with basal white bands. The tarsi have white rings basally and apically. The wings are all dark scaled except for white patch at base of costa and are about 3.0 to 3.5 mm long.

Bionomics. The larvae may be found throughout the year, in overflow pools, rockholes along mountain streams and rain-filled rockholes removed from streams. The females are persistent biters but are troublesome only locally due to their small numbers and their habit of staying near their breeding grounds.

Medical Importance. It has been shown to be capable of transmitting Eastern equine encephalitis in the laboratory (Horsefall, 1955).

Distribution. It is found, according to Carpenter and LaCasse (1955), from eastern United States west to New Mexico and from southern Canada to Mexico.

Kansas Distribution. It has been found in Cowley county (Beadle, 1944); Allen, Cherokee and Montgomery counties (Anonymous, 1951); and in the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) canadensis canadensis (Theobald)

Culex canadensis Theobald, 1901, Mon. Culic., 2:3. Synonomy: Culex nivitarsis Coquillett, 1904 (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium sized with narrow golden brown scales on the mesonotum. The abdomen is dark scaled with narrow basal white bands and prominent basolateral patches of white scales. The tarsi are ringed basally and apically with white scales. The wings have narrow dark scales and are about 3.2 to 4.0 mm in length.

Bionomics. The larvae are found in pools of cool clear water which contains fallen leaves, also in pools and ditches near wooded areas. The females are persistent biters which attack man readily in shaded situations throughout most of the day.

Medical Importance. It has been shown experimentally, in cages, by Yen to be a suitable host for Dirofilaria immitis (Horsefall, 1955).

Distribution. Carpenter and LaCasse (1955) listed it as widely distributed in the forested areas of the United States.

Kansas Distribution. This species has been reported from Labette county (Beadle, 1944); from Bourbon and Leavenworth counties (Anonymous, 1951), and as scarce and locally distributed from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Aedes) cinereus Meigen

Aedes cinereus Meigen, 1818, Syst. Beschr. Zweifl. Ins., 1:13. Synonomy:

Aedes fuscus Osten Sacken, Aedes cinereus fuscus Dyar, Aedes cinereus hemisleus Dyar and others according to Carpenter and LaCasee (1955).

Recognition Characters. The adult female is medium sized to rather small with the mesonotum evenly clothed with fine narrow reddish brown scales. The abdomen is brown and may have partial or complete narrow basal bands. The femora and tibiae are dark with the posterior surfaces being pale, and the tarsi dark. The wings have narrow brown scales and are about 3.2 to 3.8 mm in length.

Bionomics. The larvae may be found in woodland pools, unshaded temporary rain-filled pools, and in marshes. The adult female will feed at any time when encountered in the wooded area according to Owen (1937).

Medical Importance. Horsefall (1955) reports that Olin found this species could be a reservoir for the bacteria that causes tularemia in Sweden.

Distribution. It is found throughout the United States.

Kansas Distribution. This species has been reported from Montgomery county (Beadle, 1944); from Republic county (Anonymous, 1951), from the Arkansas-White-Red river basin by McNeel and Ferguson (1954) and Riley county (KSC).

Aedes (Ochlerotatus) dorsalis (Meigen)

Culex dorsalis Meigen, 1830, Syst. Beschr. Zweifl. Ins., 6:242. Synonomy: Aedes grahami Ludlow, Aedes quaylei Dyar and Knab and others according to Carpenter and LaCasee (1955).

Recognition Characters. The adult female is medium sized with a median longitudinal stripe of brown scales on the mesonotum. The abdomen

has transverse segmental bands and a median dorsal stripe of white scales. The femora, tibiae and first tarsal segment are yellowish white scaled, speckled with dark scales. Segments 1 to 3 of the hind tarsi are ringed basally and apically with white, segment 4 has a basal ring and a few scales apically, and segment 5 is entirely white. The wings have narrow dark brown scales with white scales intermixed, the white usually being predominant.

Bionomics. The larvae may occur in both brackish and fresh water and in a variety of habitats, preferring alkaline water in grassy situations exposed to sunlight according to Carpenter and LaCasse (1955). The adult females are vicious biters which attack at any time day or night, but are more active toward evening or on calm cloudy days.

Medical Importance. Western equine encephalitis has been isolated from wild caught species in California and Colorado in addition to the California encephalitis virus which was isolated from wild caught specimens (Carpenter and LaCasse, 1955).

Distribution. It is found throughout the United States in unforested areas according to Horsefall (1955).

Kansas Distribution. It has been reported from Ft. Riley and Saline county by Olson and Keegan (1944a); from Cowley, Montgomery, Labette, Riley, Shawnee and Sedgwick counties (Beadle, 1944); from Barton, Clark, Ellsworth, Finney, Geary, Kingman, Leavenworth, Republic, Rice, Russell, Seward and Stafford counties (Anonymous, 1951); and from the Arkansas-White-Red River Basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) dupreei (Coquillett)

Aedes (Ochlerotatus) dupreei (Coquillett). Culex dupreei Coquillett, 1904, Can. Ent., 36:10.

Recognition Characters. The adult female is small and has a broad (slightly more than one-third as wide as the scutum) longitudinal stripe of silver-white scales on the mesonotum. The tergites of the abdomen are dark with white basolateral patches. The legs are dark except the coxae of the forelegs which are white and the posterior surface of the femora, tibiae and first segment of the tarsi are pale scaled. The wings have narrow brown scales and are about 2.5 mm in length.

Bionomics. The larvae are found in temporary rain-filled pools in woodlands where they hide among the leaves and debris and are difficult to collect.

Medical Importance. It is not known to be of any medical importance. The females do not appear to be attracted to man according to Howard, Dyar, and Knab as reported by Carpenter and LaCasse (1955).

Distribution. It is found in Southeastern United States north to New Jersey and west to Kansas and Texas according to Carpenter and LaCasse (1955).

Kansas Distribution. It has been reported as being rare from Montgomery and Labette counties (Beadle, 1944); and locally distributed and unimportant from the Arkansas-White-Red River Basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) flavescens (Muller)

Culex flavescens Muller, 1764, Fauna Ins. Fried., p. 87. Synonomy: Culex lutescens Fabricius, Culex variegatus Shrank, Culex bipunctatus Robineau-

Desvoidy, Culex arcanus Blanchard, and Culex fletcheri Coquillett, according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is large and yellowish; the mesonotum is clothed with yellow to brown scales and has a median broad stripe of bronzy brown scales. The abdomen is covered with dull yellow scales. The wing scales are predominantly yellow with brown intermixed and are about 5.5 to 6.0 mm in length.

Bionomics. Larvae appear early in the spring in deep temporary pools in meadows and marshes on open plains. Adults are not found in great numbers but are vicious biters, biting during the day and early evening, but usually attacking large animals more often than man (Carpenter and LaCasse, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in the interior plains of the northern United States (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported by Olson and Keegan (1944a) from Saline county, and as scarce, locally distributed, and unimportant in the Arkansas-White-Red River Basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) nigromaculis (Ludlow)

Grabhamia nigromaculis Ludlow, 1907, Geo. Wash. Univ. Bull., 5:85.

Recognition Characters. The adult female is medium sized and has a broad median stripe of golden-brown scales on the scutum. The posterior pronotum has narrow bronze-brown scales and the scutellum has yellow scales with darker setae on the lobes. The yellowish scales on the abdomen form a median longitudinal stripe.

Bionomics. The larvae may occur in rain-filled depressions and irrigation ditches, occurring mostly in alkaline waters. The adult females bites readily but is more active in the evening (Carpenter and LaCasse, 1955). It is regarded by Tate and Gates (1944) as a major pest in Nebraska where it reaches its greatest abundance during the spring and early summer. The adults are strong fliers and are commonly found several miles from their breeding grounds.

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in central and western United States according to Carpenter and LaCasse (1955).

Kansas Distribution. It is reported from Clark, Dickinson, Douglas, Franklin, Lyons, Riley and Saline counties by DeMoss (1937); from Cowley, Labette, Montgomery, Sedgwick and Shawnee counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Cloud, Decatur, Ellsworth, Finney, Geary, Kingman, Leavenworth, McPherson, Neosho, Pratt, Republic, Rice, Saline, Seward and Stafford counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) sollicitans (Walker)

Culex sollicitans Walker, 1856, Ins. Saund., Dipt., p. 427.

Recognition Characters. The adult female is medium sized and has a dark scaled proboscis with a white ring near the middle. The scutum has golden to golden brown scales dorsally becoming bronze-brown laterally. The first tergite of the abdomen has a median patch of yellowish-white scales; each remaining tergite is white laterally and pale yellow medially.

Bionomics. The larvae may be found in brackish water swamps,

particularly in the oil fields. The females are persistent biters and strong fliers and may migrate many miles from their breeding grounds. They will attack during the day or night and especially if their resting place, which is usually vegetation, is disturbed during the day (Carpenter and LaCasse, 1955).

Medical Importance. It has been shown that this species can become infected and transmit eastern equine encephalitis in the laboratory and that it can become infected in the laboratory with western equine encephalitis (Horsefall, 1955).

Distribution. It occurs in the Gulf and Atlantic coasts of the United States and in some inland states where brackish water occurs (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported in Allen, Finney, Rawlins, Rice and Stafford counties (Anonymous, 1951) and from the Arkansas-White-Red river basin by McNeal and Ferguson (1954).

Aedes (Ochlerotatus) spencerii (Theobald)

Culex spencerii Theobald, 1901, Mon. Culic., 2:99.

Recognition Characters. The adult female is medium sized. The integument of the scutum is black and the scutum is clothed with narrow yellowish-white scales and has a broad medium longitudinal stripe of brown scales which extends from near the anterior margin posteriorly to the prescutellar space. The first tergite of the abdomen is white scaled; each remaining tergite has an apical white band and a medium white stripe or may be entirely white scaled.

Bionomics. The larvae are found in temporary pools. The adult females

are diurnal, very abundant during early summer and very annoying in the prairie regions (Carpenter and LaCasse, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It occurs in the prairie regions of northern United States and southern Canada.

Kansas Distribution. It has been reported from Republic county (Anonymous, 1951) and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) sticticus (Meigen)

Culex sticticus Meigen, 1838, Syst. Beschr. Zweifl. Ins., 7:1. Synonomy: Culex hisuteron Theobald, Culex aestivalis Dyar, Culex pretans Grossbeck, Aedes aldrichii Dyar and Knab, Aedes gonimus Dyar and Knab, Aedes vinnipegensis Dyar and Aedes lateralis (Meigen) according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is medium sized. The scutum has yellowish-white scales with two medium stripes of golden brown scales which extend to the pale scaled prescutellar space. The first tergite of the abdomen has a median patch of white scales; each remaining tergite is dark scaled and has a narrow basal white band which broadens laterally into a basal triangular white patch.

Bionomics. The larvae are found in flood water pools and in rain pools which contain dead leaves or other vegetable matter. The adults are persistent biters and attack during the daytime and early evening near their breeding grounds in woodlands and thickets according to Carpenter and LaCasse (1955). According to Matheson (1944) the females may migrate

several miles.

Medical Importance. According to Hammon and Reeves (1943) it is possible to infect a laboratory strain which was able to transmit eastern encephalitis in the laboratory.

Distribution. It is widespread over the United States.

Kansas Distribution. It has been reported by Olson and Keegan (1944a) from Ft. Leavenworth, Ft. Riley, Cloud and Shawnee counties; from Labette, Montgomery, and Sedgwick countiee by Beadle (1944); from Allen, Bourbon, Geary, Johnson, Leavenworth and Logan counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) stimulans (Walker)

Culex stimulans Walker, 1848, List Dipt. Brit. Mus., 1:4. Synonomy: Culicada subcantans Felt, Aedes mercurator Dyar, Aedes stimulans classicus Dyar, Aedes stimulans mississippii Dyar and Aedes stimulans albertae Dyar according to Carpenter and LaCasee (1955).

Recognition Characters. The adult female is medium sized with a dark proboscis sprinkled with white scales. The scutum has yellowish white to light brown scales and a broad median longitudinal stripe of brown scales or a varying pattern of brown and paler scales. The first abdominal tergite has a median patch of white scales; each remaining tergite has a broad basal band of white to pale yellow scalee, the apical half being dark may be speckled with white scales.

Bionomics. The larvae are found in temporary, usually woodland, pools from overflowing streams, melting snow and early spring rains. The adult females are found usually in spring and early summer and are persistent

biters, feeding readily in the woods at all hours (Carpenter and LaCasse, 1955).

Medical Importance. It has been reported that the females are able to transmit fowl pox in the laboratory (Horsefall, 1955).

Distribution. It is usually found in northern United States but may range as far south as Mississippi (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Leavenworth county (Anonymous, 1951) and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Finlaya) triseriatus (Say)

Culex triseriatus Say, 1823, Jour. Acad. Nat. Sci. Phila., 3:12. Synonomy: Finlaya nigra Ludlow and Aedes triseriatus var. hendersoni Cockerell according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is medium sized and has a wide median stripe of dark brown scales on the scutum which is broader dietally and covers most of the posterior half of the scutum. The sides of the scutum are clothed in white scales. The tergites of the abdomen are blue black scaled with basal patches of white scales laterally.

Bionomics. The larvae are found in tree holes of many deciduous trees and some artificial wooden containers. The female is a persistent biter and very painful biter. The female is most active during the early morning and evening hours, for which reasons they are not often caught in light traps (Carpenter and LaCasse, 1955).

Medical Importance. It is possible to accomplish laboratory infection and transmission of eastern encephalitis with this species (Horsefall, 1955).

Distribution. It is found in eastern United States south to Florida Keys and west to Utah and Idaho (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Douglas and Riley counties by DeMoss (1937); from Cowley, Labette, Montgomery, Sedgwick and Shawnee counties by Beadle (1944); from Allen, Anderson, Bourbon, Cherokee, Crawford, Ellis, Geary, Harvey, Johnson, Leavenworth, Neosho, Pottawatomie, Rawlins, Republic, Rice, Salins, Wilson, and Woodson counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Ochlerotatus) trivittatus (Coquillett)

Culex trivittatus Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:193. Synonomy: Culex inconspicuous Grossebeck (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium sized, with the scutum having a pair of submedian stripes of white to yellowish-white scales separated by a median brown stripe of equal width and the scales on the sides of the scutum bronze-brown in color. The first abdominal tergite is dark scaled; the remaining tergites are dark scaled but have basolateral patches of white scales.

Bionomics. The larvae are found during the summer in rainpools in meadows, swamps and woodlands. The adult female is a persistent biter and attacks during the day or at dusk (Carpenter and LaCasse, 1955).

Medical Importance. A virus related to California encephalitis has been isolated from adult females according to Hammon et al. (1952).

Distribution. This species is found in eastern United States west to Idaho and New Mexico (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Ft. Leavenworth, Ft. Riley, Leavenworth, Saline and Shawnee counties by Oleon and Keegan (1944a); from Cowley, Labette, Montgomery, Riley, and Sedgwick counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Cloud, Douglas, Ellsworth, Finney, Geary, Johnson, McPherson, Morris, Neosho, Pottawatomie, Rawlings, Republic and Rice counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Aedimorphus) vexans (Meigen)

Culex vexans Meigen, 1830, Syst. Beschr. Zweifl. Ins., 6:241. Synonomy: Culicada minuta Theobald, Aedes cucohrus Howard, Dyar, and Knab, and others according to Carpenter and LaCasse (1955).

Recognition Characters. The female is medium sized with a dark scaled proboscis sprinkled with light brown scales. The scutum is clothed with golden brown scales which are paler on the anterior and posterolateral margins. The first abdominal tergite is dark with pale scales intermixed on the median area; tergites II to IV are dark scaled and have a conspicuous indented basal white band and basolateral white patches which are not connected; the remaining tergites have white scales on their apical margin.

Bionomics. The larvae are found in rain filled pools, irrigation seepage and pools formed by floodwaters. The adults are vicious biters. It feeds in shady areas during the day and is particularly annoying at dusk and after dark (Carpenter and LaCasse, 1955). It has been reported by Reese (1943) that the flight range may be from five to eight miles.

Medical Importance. It has been shown that it is capable of laboratory transmission of eastern encephalitis (Hammon and Reeves, 1943). It is one

of the major pest species in Kansas.

Distribution. It may be found in most parts of the United States.

Kansas Distribution. It has been reported from Atchison, Douglas, Doniphan, Gray, Phillips, Pratt, Riley, Sheridan, Stafford, and Wyandotte counties by DeMoss (1937); from Cowley, Labette, Montgomery, Sedgwick, and Shawnee counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Butler, Cherokee, Clark, Cloud, Crawford, Ellis, Ellsworth, Finney, Franklin, Geary, Harvey, Johnson, Kingman, Leavenworth, Linn, McPherson, Marion, Neosho, Pottawatomie, Rawlins, Reno, Republic, Rice, Saline, and Seward counties (Anonymous, 1951); and from Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Aedes (Finlaya) zoosophus Dyar and Knab

Aedes zoosophus Dyar and Knab, 1918, Ins. Ins. Mens., 5:165. Synonomy: Aedes alleni Turner, according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is medium sized. The scutum is silver scaled with a median golden-brown stripe on the anterior half; the posterior half is dark brown with silvery scales bordering the prescutellar space and forming a narrow line on either side. The first abdominal tergite has a median patch of dark scales; the remaining tergites are bronze-brown scaled with narrow basal cream white bands and silver white lateral patches.

Bionomics. The larvae are usually found in rot cavities of trees and occasionally in artificial containers. The adult female readily attacks man during the early morning and evening hours.

Medical Importance. It is not known to be of medical importance.

Distribution. It has only been reported from Kansas, Oklahoma and Texas.

Kansas Distribution. It has been reported from Cowley, Montgomery, and Sedgwick counties by Beadle (1944); from Geary county (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeal and Ferguson (1954).

Genus Culex. This genus is one of the most important genera in Kansas. Its members produce large populations which are troublesome to man as biters with some species capable of transmitting various strains of mosquito-borne encephalitides.

The genus is separated from other members of the tribe in that the wing scales are narrow and uniformly dark and in the lack of spiracular and post-spiracular bristles.

The unique eggs are fixed together in raft-like masses which are characteristic for most species. The larvae are found in permanent or semi-permanent ground pools but may utilize various artificial containers (Carpenter and LaCasse, 1955).

The members of the genus which occur in the United States are separated into three subgenera, Culex, Melanoconion and Neoculex (Carpenter and LaCasse, 1955). The division into subgenera is based on male characteristics principally and will not be used for general classification.

Key to Adult Female Culex Mosquitoes in Kansas, Adapted from Carpenter and LaCasse (1955).

1 Wing scale broadened on vein 2 2

1' Wing scales not broadened on vein 2 3

2 Abdominal tergites with narrow basal bands ..... erraticus

2' Abdominal tergites have small basolateral white patches, otherwise dark scaled ..... peccator

3 Tarsi have distinct white rings ..... tarsalis

3' Tarsi without rings (if present they are brown) 4

4 Abdominal segments with apical triangle of pale scales on sides joined by dorsoapical narrow band of pale scales ..... territans

4' Abdominal segment with basal band of pale scales 5

5 Abdominal segment with narrow band of yellowish scales. Segment VII entirely clothed with pale scales ..... salinarius

5' Abdominal segments with broad band of whitish scales 6

6 Abdominal bands narrowly joining or disconnected from lateral patches and rounded on posterior margin 7

6' Abdominal bands broadly joining lateral patches. Scutum has a pair of submedian pale spots ..... restuans

7 Abdominal bands almost disconnected from basolateral patches..... ..... quinquefasciatus

7' Abdominal bands more broadly joined to sides ..... pipiens

Culex (Melanoconion) erraticus (Dyar and Knab)

Mochlostyrax erraticus Dyar, 1905, Jour. N. Y. Ent. Soc., 14:224 (larva described). Synonomy: Culex peccator Dyar and Barrett, Culex degustator Dyar and Knab, Culex erraticus King and Bradley, and others according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is small with a long, dark proboscis. The tergites are dark-brown scaled and usually have narrow white basal bands and white basolateral patches. The abdominal sternites are white-banded basally and dark apically. The legs are dark scaled except for a pale posterior area on the femora and small pale knee spots.

Bionomics. The larvae are found in grassy pools, ditches, marshy areas and lakes. The adults prefer the blood of a fowl and are not troublesome biters (Anonymous, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in southern United States north to Michigan and west to North Dakota and Texas (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Ft. Leavenworth, Salina and Shawnee counties by Oleon and Keegan (1944a); Cowley, Montgomery, Labette and Sedgwick counties by Beadle (1944); Allen, Anderson, Barton, Bourbon, Butler, Cherokee, Crawford, Douglas, Ellsworth, Geary, Greenwood, Johnson, Leavenworth, Linn, McPherson, Marion, Morris, Neosho, Reno, Rice, Wabaunsee and Wilson counties (Anonymous, 1951); and the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Culex (Culex) quinquefasciatus Say

Culex quinquefasciatus Say, 1823, Jour. Acad. Nat. Sci. Phila., 3:10.
Synonomy: Culex fatigans Wiedemann (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium sized with a dark scaled proboscis. The scutum is clothed with brown hairs. The first abdominal tergite has a median patch of dark bronze scales; the remaining tergites are dark scaled and have conspicuous white basal bands which are rounded on the posterior margin and very narrow at the side or disconnected at the sides where they join the white lateral patches. The legs are dark scaled except for the posterior surface of the femora, which is pale, and pale knee spots.

Bionomics. The larvae are found in a variety of impounded waters such as rain barrels, tubs, storm sewers and other similar waters. The adult is a troublesome biter at night in houses.

Medical Importance. It has been shown to be capable of transmitting St. Louis encephalitis in the laboratory (Anonymous, 1955).

Distribution. It occurs in the southern United States north to Ohio.

Kansas Distribution. It has been reported from Douglas county by DeMose (1937); from Cowley, Labette, Montgomery, Riley, Sedgwick and Shawnee counties by Beadle (1944); from Bourbon, Butler, Cherokee, Cowley, Crawford, Finney, Ford, Geary, Greenwood, Harvey, Kingman, Leavenworth, Pratt, Reno, Republic, Seward, Wabaunsee, Wilson and Woodson counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Culex (Culex) restuans Theobald

Culex restuans Theobald, 1901, Mon. Culic., 2:142. Synonomy: Culex brehmei Knab (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium sized with some pale scales on the venter of the dark scaled proboscis. The scutum is clothed with golden brown scales which are paler on the anterior and lateral margins and a pair of small submedian pale spots. The first abdominal tergite has a median patch of dark scales; each remaining tergite has a basal band of yellowish-white scales which is broadly joined to the lateral patches. The legs are dark scaled with the exception of the posterior surface of the femora and tibiae and the knee spots, which are pale.

Bionomics. The larvae may be found in rain barrels, pools, ditches, and other similar water. The adults may be found in houses and are troublesome biters.

Medical Importance. It has been found infected with western equine encephalomyelitis virus, but it is not known if it is able to transmit it (Anonymous, 1955).

Distribution. It is found throughout the United States.

Kansas Distribution. It has been reported from Cowley, Labette,

Montgomery, Riley, Sedgwick and Shawnee counties by Beadle (1944); from Allen, Barton, Bourbon, Butler, Cherokee, Cloud, Crawford, Douglas, Ellis, Ellsworth, Finney, Ford, Kingman, Leavenworth, Marion, Pratt, Reno, Republic, Rice, Rush, Saline, Wabaunsee, Wilson and Woodson counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Culex (Culex) salinarius Coquillett

Culex salinarius Coquillett, 1904, Ent. News, 15:73.

Recognition Characters. The adult female is medium sized and has a dark proboscis which is paler on the ventral side. The scutum is clothed with golden brown scales which are paler on the anterior and lateral margins. The first abdominal tergite has a median patch of dark brown scales; each remaining tergite has a basal band of dingy yellow scales which is broadly joined with basolateral dingy yellow scales. The legs are dark except the posterior surface of the femora and tibiae which are pale.

Bionomics. The larvae may be found in fresh or foul grassy pools, ditches, cattle tracks, barrels, bilge water, and various other impounded water. The adult female bites readily outdoors and occasionally enters a house (Anonymous, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in eastern United States and is known to extend as far west as Utah (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Ft. Leavenworth, Ft. Riley, Cloud, Saline and Shawnee counties by Olsen and Keegan (1944a); from Cowley, Labette, Montgomery, Riley and Sedgwick counties by Beadle

(1944); from Allen, Anderson, Barton, Bourbon, Butler, Cherokee, Crawford, Douglas, Finney, Geary, Greenwood, Neosho, Reno, Republic, Rice, Rush, Seward, Wilson and Woodson counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Culex (Culex) tarsalis Coquillett

Culex tarsalis Coquillett, 1896, Can. Ent., 28:43. Synonomy: Culex willistoni, Culex affinis Adams, Culex kelloggi Theobald, and Culex pecus Speiser (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium-sized with a dark scaled proboscis which has a broad median white band. The scutum is clothed with golden brown scales and a narrow margin of white scales both anteriorly and laterally; in addition there is a pair of submedian white lines which extend forward to near the middle of the scutum and end in a small white submedian spot. The first abdominal tergite has a patch of dark brown scales, with a few pale scales intermixed; the second tergite has a median basal triangular patch of pale scales; each remaining tergite is dark scaled and has a prominent basal band of whitish scales. The terminal segments may have apical as well as basal bands of pale scales; and the eighth tergite may be completely pale scaled. The legs are dark except the posterior surface of the femora and tibiae and the narrow stripe of pale scales on the anterior surface of the femora and tibias.

Bionomics. The larvae may be found in fresh or foul water, ditches, ground pools and rain barrels. The adult female bites readily outside and occasionally invades the house (Anonymous, 1955).

Medical Importance. It has been reported by various authors as being

the natural vector of St. Louis encephalitis, is able to transmit western equine virus in the laboratory, Dirofilaria immitis larvae reached maturity in the mosquito, host to Wuchereria bancrofti and serves as laboratory vector of Japanese B. encephalitis (Lungstrom, 1950).

Distribution. It is found in the western, central and southern United States.

Kansas Distribution. It has been reported from Douglas, Clay, Riley and Chautauqua counties by DeMose (1937); from Cowley, Labette, Montgomery, Sedgwick and Shawnee counties by Beadle (1944); from Allen, Anderson, Barber, Barton, Bourbon, Butler, Cherokee, Clark, Cloud, Crawford, Dickinson, Ellis, Ellsworth, Finney, Ford, Geary, Harvey, Johnson, Kingman, Leavenworth, Linn, McPherson, Marion, Nemaha, Norton, Pratt, Reno, Republic, Rice, Rush, Saline, Seward, Stafford, Stanton, Wilson and Woodson counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Culex (Culex) pipiens Linnaeus

Culex pipiens Linnaeus, 1758, Syst. Nat. Ed., 10:602.

Recognition Characters. The adult female is medium-sized and has a dark-scaled probosois. The scutum is clothed with brown hairs. The first abdominal tergite has a median patch of dark bronze scales; each remaining tergite is dark scaled and has a conspicuous white basal band which is rounded on its posterior margin and narrow at the side where it joins the white lateral patches. The legs are dark scaled except the posterior surface of the femora and the knee spots which are pale.

Bionomics. The larvae may be found practically in any collection of polluted water such as rain barrels, tubs, cesspools, ditches and others.

The adults usually invade houses and bite at night (Carpenter and LaCasse, 1955).

Medical Importance. It has been incriminated in the transmission of western equine and St. Louis encephalitis viruses (Anonymous, 1955).

Distribution. It is distributed throughout the United States except in the extreme south.

Kansas Distribution. It has been reported from Clay and Riley counties by DeMoss (1937); from Allen, Anderson, Bourbon, Butler, Cherokee, Clay, Cloud, Cowley, Crawford, Douglas, Ellsworth, Finney, Geary, Labette, Leavenworth, Marion, Montgomery, Morris, Pratt, Reno, Republic, Saline, Sedgwick, Shawnee, and Wabaunsee counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Culex (Melanoconion) peccator Dyar and Knab

Culex peccator Dyar and Knab, 1909, Smithson. Misc. Coll., 52:256. Synonomy: Culex incriminator Dyar and Knab and Culex peccator King and Bradley, 1937 (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is small with a long dark proboscis. The scutum is clothed with brown scales. The abdominal tergites are clothed with dark scales and have small basolateral white patches. The legs are dark scaled except for the pale posterior surface of the femora and small pale knee spots.

Bionomics. The larvae are found in pools of streams and in marshy areas. Adults prefer blood of fowls and are not troublesome biters (Anonymous, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in southeastern United States north to Michigan and west to Kansas and Texas (Carpenter and LaCasse, 1955).

Kansas Distribution. It is reported from Ft. Leavenworth by Oleon and Keegan (1944); Cherokee, Leavenworth, Reno and Labette counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Culex (Neoculex) territans Walker

Culex territans Walker, 1856, Ins. Saund., Dipt., 1:428. Synonomy: Culex saxatilis Grossbeck, Culex friekii and others according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is small and has a long dark scaled probosois. The scutum is clothed with light brown scales with the scales on the anterior margin being paler. The first abdominal tergite has a median patch of dark scales; each remaining tergite is dark scaled and has an apical band of white scales which joins a triangular patch of pale scales on each side. The legs are dark scaled except for the pale posterior surface of the femora and tibias and the small pale knee spots.

Bionomics. The larvae may be found in permanent or semipermanent pools, streams, swamps and ponds. The adults, which very seldom enter homes, have been observed biting cold blooded vertebratee (particularly frogs) but will occasionally bite man (Carpenter and LaCasse, 1955).

Distribution. It occurs throughout most of the United States.

Kansas Distribution. It has been reported from Riley and Shawnee counties by DeMoss (1937); from Cowley, Labette, Montgomery and Sedgwick counties by Beadle (1944); from Allen, Anderson, Bourbon, Cherokee, Cloud,

Crawford, Douglas, Finney, Geary, Greenwood, Johnson, Kingman, Leavenworth, Marion, Neosho, Republic, Rice, Saline, Wilson and Woodson counties (Anonymous, 1951); and from the Arkansas-White-Red river basin by McNeel and Ferguson (1954).

Genus Culiseta. This genus is represented in Kansas by only one known species. It is one of the first species found in late winter and early spring. It is important medically in that it has been found in nature harboring western equine encephalitis virus.

It is separated from the other genera in that it has spiracular bristles, blunt abdomen and crocs veins in the wing which are nearly in line.

Culiseta (Culiseta) inornata (Williston)

Culex inornatus Williston, 1893, U. S. Dept. Agr. Div. Ornith. and Mam., N. Amer. Fauna, 7:253. Synonomy: Culex magnipennis Felt (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is large with the proboscis dark and speckled with pale scales. The scutum is clothed with golden brown and pale yellow intermixed scales on the dorsal surface; the anterior and lateral margins are pale yellow scaled. The first abdominal tergite has a median patch of yellowish white scales; tergites II to VII are dark brown and have yellowish basal bands which widen laterally to cover the full length of the tergites; the eighth tergite is entirely pale scaled. The legs are dark brown and may be speckled with pale scales.

Bionomics. The larvae may be found in ditches and various other pools including some artificial containers which are usually foul. The adults seldom attack man (Carpenter and LaCasse, 1955).

Medical Importance. It has been reported that it may be a reservoir for western encephalitis and that it can transmit eastern encephalitis in the laboratory (Horsefall, 1955).

Distribution. It is found throughout the United States.

Kansas Distribution. It has been reported from Clark, Douglas and Riley counties by DeMoss (1937); from Cowley, Labette, Montgomery, Sedgwick, and Shawnee counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Cherokee, Cloud, Crawford, Douglas, Ellsworth, Finney, Ford, Geary, Johnson, Kingman, Leavenworth, McPherson, Marion, Neosho, Reno, Republic, Rice, Saline, Seward and Woodson counties (Anonymous, 1951); from the Arkansas White-Red river basin by McNeel and Ferguson (1954); and from Pottawatomie county (KSC).

Genus Mansonia. This is a small genus of which one species occurs in Kansas. The adults may be separated from the other genera in that it has a blunt abdomen, broad scales which are mixed brown and white, and the mesonotum is without lines of white scales.

The adult females lay their eggs in rafts upon the surface of water containing dense vegetation. When the larvae hatch, they attach themselves to the stems and roots of certain types of plants from which both the larvae and pupae receive their air supply (Carpenter, 1941).

Mansonia (Coquillettidia) perturbans (Walker)

Culex perturbans Walker, 1856, Ins. Saund., Dipt., p. 428. Synonomy: Culex testaceus Van der Wulp and Culex ochropus Dyar and Knab (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is large and has a dark pro-

boscis which is sprinkled with white scales basally and has a broad median ring of pale scales. The scutum has intermixed dark brown and pale golden scales. The first tergite is dark scaled; the remaining tergites are dark with pale yellow basolateral patches and occasionally have narrow basal segmental bands of pale scales.

Bionomics. The larvae are difficult to capture because they attach themselves to the underwater stems of aquatic vegetation where they remain throughout their development. The adult females bite principally at night, can migrate many miles, and are very troublesome to man (Carpenter, 1941).

Medical Importance. A filterable virus, immunologically and antigenically identical to that of eastern equine encephalitis, has been recovered from wild caught specimens in Georgia (Carpenter and LaCasse, 1955).

Distribution. It occurs throughout most of the United States.

Kansas Distribution. It has been reported to occur in Riley county by DeMose (1937); from Ft. Riley and Shawnee county (Olson and Keegan, 1944); from Cowley and Montgomery counties (Beadle, 1944); from Allen, Bourbon, Cherokee, Johnson, Labette, Leavenworth and Linn counties (Anonymous, 1951); and from the Arkansas White-Red river basin (McNeil and Ferguson, 1954).

Genus Orthopodomyia. Two of the three species found in the United States occur in Kansas. All the species are very similar and can be readily distinguished only in the larval stage.

It is separated from the other genera in that it has a blunt abdomen, broad wing scales, the mesonotum has fine longitudinal lines of white scales and the fourth tarsal segment is as long as wide.

Key to Kansas Orthopodomyia - Adult Females.

1 Tarsal bands placed evenly on joints ..... alba

1' Tarsal band uneven on joints ..... signifera

Key to Kansas Orthopodomyia - 4th Instar Larvae Adapted from Carpenter and LaCasse (1955).

1 Siphon tuft 2 - 4 branched; abdominal segment VIII without sclerotized plate ..... alba

1' Siphon tuft with more than 4 branches; abdominal segment VIII with a sclerotized plate ..... signifera

Orthopodomyia signifera (Coquillett)

Culex signifera Coquillett, 1896, Can. Ent., 28:43. Synonomy: Mansonia waverleyi Grabham (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium sized and has a long dark proboscis with numerous white scales forming narrow longitudinal lines dorsally. The scutum has long dark setae, small reddish brown scales and three paired narrow longitudinal lines of silver white scales. The first abdominal tergite had a median patch of broad pale scales; the second has a pale basal band which nearly projects to the apical margin; and the remaining tergites are dark scaled.

Bionomics. The larvae may be found in water filled rot cavities in trees and occasionally in artificial containers. The adult has not been known to bite man (Carpenter and LaCasse, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in southern United States north to Massachusetts and west to North Dakota and New Mexico.

Kansas Distribution. It has been reported from Ft. Leavenworth by Olson and Keegan (1944a); from Cowley, Labette, Montgomery and Sedgwick counties by Beadle (1944); from Allen, Barton, Bourbon, Douglas, Finney, Geary, Johnson, Leavenworth and McPherson counties (Anonymous, 1951);

and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Orthopodomyia alba Baker

Orthopodomyia alba Baker, 1936, Proc. Ent. Soc. Wash., 38:1.

Recognition Characters. The adult female appears to be indistinguishable from Orthopodomyia signifera with the exception that the bands on the hind tarsal segments are more evenly placed on the joints (Carpenter and LaCasee, 1955).

Bionomics. The larvae may be found in water-filled rot cavities in trees and occasionally in artificial containers. Very little information is known about the feeding of the adults (Carpenter and LaCasse, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in the eastern and central United States.

Kansas Distribution. It has been reported from Ft. Leavenworth, Ft. Riley and Saline county by Olson and Ksegan (1944a); from Riley county by Beadle (1944); from Allen, Bourbon, Dickinson, Geary and Leavenworth counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Genus Psorophora. This genus is separated into three subgenera: Psorophora, Janthinosoma and Grabhamia. The adults are separated from the other genera by the presence of epiracular and postspiracular bristles, abdomen of female tapered and the postnotum bare.

The eggs are laid singly in depressions where the water will gather after a rain. The larvae develop rapidly and the larvae of the subgenus Psorophora are predacious on other mosquito larvae associated with them (Carpenter and LaCasee, 1955). The adult female is a vicious and troublesome

biter.

Key to Kansas Species of Psorophora - Adult Females Adapted from Carpenter and LaCasse (1955).

1 Wing scales mixed dark and white 2

1' Wing scales all dark or only few inconspicuous white scales on costa and subcosta 4

2 Segment 1 of hind tarsus white scaled at base and middle; no definite pattern in wings ..... confinnis

2' Segment 1 of hind tarsus largely pale scaled; wing with definite areas of white and dark scales 3

3 Alternating groups of dark and pale scales on fringe of wing .... sigmipennis

3' Uniformly dark scales on wing fringe ..... discolor

4 Hind legs (including apical part of femora) with long erect scales very shaggy; 5th segment hind tarsi never all white 5

4' Apical part of femora without long erect scales (when tibiae is somewhat shaggy the fifth segment of hind tarsus is all white)..... 6

5 Proboscis dark scaled; scutum without median longitudinal strips of golden scales ..... howardii

5' Proboscis yellow scaled basally; scutum with a median longitudinal strips of golden scales ..... ciliata

6 Hind tarsi entirely dark scaled ..... cyanescens

6' Hind tarsi white on apical segments 7

7 Mixed brown and golden yellow scales on scutum in no definite pattern ..... ferox

7' Scutum has a broad medium longitudinal strips of dark brown scales, and pale yellow or greyish white scales laterally 8

8 Pale knee spots present; palpi less than one-third as long as proboscis ..... horrida

8' Pale knee spots absent; palpi more than one-third as long as proboscis ..... longipalpis

Psorophora (Psorophora) ciliata (Fabricius)

Culex ciliata Fabricius, 1794, Ent. Syst., 4:401. Synonomy: Culex molestus Wiedemann, Psorophora lynchi Brethes, Psorophora otitee Dyar and others according to Carpenter and LaCasee (1955).

Recognition Characters. The adult female is very large and has a long proboscis. The scutum has a narrow medium stripe of pale golden scales and a narrow submedium stripe on either side. The first abdominal tergite has a median patch of grayish-white scales; the remaining tergites are pale yellow to brown scaled. The femora is yellow scaled and speckled with dark on basal two-thirds; the apical part is densely clothed with long erect dark scales. The tibia has long dark erect scales except for a narrow basal ring of yellow scales.

Bionomics. The larvae may be found in temporary rain-filled pools where they feed on larvae of other associated species. The females are vicious biters and may attack any time during the day (Anonymous, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in eastern United States west to South Dakota, Nebraska and Texas.

Kansas Distribution. It has been reported to occur in Atchison, Chatauqua, Dickinson, Douglas, Leavenworth, Reno, Riley, Rush and Saline counties by DeMoss (1937); from Cowley, Labette, Montgomery and Sedgwick counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Crawford, Ellsworth, Finney, Geary, Johnson, Kingman, Linn, McPherson, Neosho, Pawnee, Pratt, Republic, Rice and Seward counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Psorophora (Grabhamia) confinnis (Lynch Arribalzaga)

Taeniorhynchus confinnis Lynch Arribalzaga, 1891, Rev. Mus. de la Plata, 2:149. Synonomy: Culex iamaicensis Theobald, Janthinosoma texanum Dyar and Knab, and others according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is medium to large in size with a dark scaled proboscis which has a wide yellowish-white median band. The scutum is dark scaled except for lavender-tinted narrow white scales on the prescutellar space, the lateral angle of scutum, the scutual angle, the patch above the wing base and a submedian spot near the middle. The first abdominal tergite has a patch of greyish white scales; the remaining tergites are dark scaled and have white to pale yellow scaled apical markings which are triangular in shape on tergitee II to IV and divided into paired submedian patches on IV to VII. The femora are dark scaled and speckled with white scales, their posterior surface being largely pale scaled. The tibiae are dark with numerous small white scale spots on the outer surfaces.

Bionomics. The larvae may be found in temporary rain-filled pools. The adults probably lay their eggs on damp soil in depressions which are subject to over-flowing of streams and canals. The females are vicious biters attacking any time of day or night (Anonymous, 1955).

Medical Importance. It is not known to transmit any disease of medical importance. It is noted for its persistence in attacking man and livestock. In the Florida everglades and the rice fields of Arkansas livestock are occasionally killed and people will stay in their well-screened houses at night (Carpenter and LaCasse, 1955).

Distribution. It may be found throughout the United States, especially abundant in the southern states.

Kansas Distribution. It has been reported from Douglas, Linn and Lyon counties by DeMoss (1937); from Cowley, Labette, Montgomery, Riley, Sedgwick and Shawnee counties by Beadle (1944); from Allen, Anderson, Bourbon, Butler, Crawford, Ellsworth, Geary, Johnson, Leavenworth, Neosho, Reno, Republic and Wilson counties (Anonymous, 1951); and from Arkansas White-Red river basin by McNeel and Ferguson (1954).

Psorophora (Janthinosoma) cyaneoscens (Coquillett)

Culex cyaneoscens Coquillett, 1902, Jour. N. Y. Ent. Soc., 10:137. Synonomy: Psorophora purpurascens Edwards, Psorophora tovari Evans and Psorophora dyari petrocchi (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium to large in size with a long dark proboscis. The scutum has mostly pale yellow scales. The first abdominal tergite is largely pale scaled; tergites II to VI are black scaled and have apical submedian triangular patches of yellow scales; tergite VII is entirely dark. The femora are yellow scaled and speckled with dark scales. The tibiae and tarsi are entirely dark scaled.

Bionomics. The larvae may be found in temporary rain filled pools. The adult female which is encountered outdoors and seldom enters houses, is a vicious biter and will feed until completely engorged or brushed off (Anonymous, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in southeastern United States.

Kansas Distribution. It has been reported from Dickinson, Reno, Riley and Wyandotte counties by DeMoss (1937); from Cowley, Labette, Montgomery and Sedgwick counties by Beadle (1944); from Allen, Anderson, Barton,

Bourbon, Geary, Harvey, Leavsnworth, Linn, McPherson, Neosho, Pottawatomie, Rice, Saline, Seward, Shawnee and Summer counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Peorophora (Grabhamia) discolor (Coquillett)

Culex discolor Coquillett, 1903, Can. Ent. 35:256.

Recognition Characters. The adult female is medium sized and has a dark scaled proboscis which has a wide median pale yellow band. The scutum is clothed with pale yellow to golden brown scales. The first abdominal tergite has greyish-white scales on the median area; the remaining tergites are greyish white scaled with dark scales intermixed. The femora have intermixed brown and pale scales; the tibiae are pale scaled with a few dark scales intermixed.

Bionomics. The larvae may be found in temporary rain filled pools and various flooded areas. The females are persistent biters when occurring in large numbers (Anonymous, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in southern United States north to New Jersey, west to Nebraska and New Mexico (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Ft. Leavenworth, Ft. Riley, Saline and Shawnee counties by Olson and Keegan (1944a); from Cowley, Labette, Montgomery, Riley and Sedgwick counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Butler, Geary, Johnson, Leavenworth, Linn, McPherson, Neosho, Pratt, Republic, Rice and Seward counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Psorophora (Janthinosoma) ferox (Humboldt)

Culex ferox Humboldt, 1820, Voy. Reg. Equin., 7:119. Synonomy: Janthinosoma coquilletti Theobald, Janthinosoma terminalis Coquillett and others according to Carpenter and LaCasse (1955).

Recognition Characters. The adult female is medium sized and has a long dark proboscie. The scutum is clothed with dark brown and golden yellow to yellowish white scales which are not arranged in a definite pattern. The first abdominal tergite has a median patch of dark purplish scales; the remaining tergites are dark scaled. The femora are dark except for the posterior surface which is pale.

Bionomics. The larvae may be found in temporary rain filled pools and pot holes in streams. The females are persistent and painful biters and attack man readily (Carpenter and LaCasse, 1955).

Medical Importance. It is not known to be of medical importance in the United States, but it has been found to be carrying eggs of Dermatobia in Panama (Carpenter and LaCasse, 1955). Dermatobia is a genus of warble flies of the family Oestrus which deposits its eggs on the body of mosquitoes, flies or ticks and are then transported to their host.

Distribution. It is found in eastern United States.

Kansas Distribution. It has been reported from Ft. Leavenworth and Saline county by Olson and Keegan (1944a); from Labette, Montgomery and Sedgwick counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Butler, Douglas, Ellsworth, Johnson, Leavenworth, Neosho, Republic and Rice counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Psorophora (Janthinosoma) horrida (Dyar and Knab)

Aedes horridus Dyar and Knab, 1908 (in par), Proc. U. S. Nat. Mus., 35:56. Synonomy: Psorophora horridus, Howard, Dyar and Knab and Psorophora horrida Roth (Carpenter and LaCasee, 1955).

Recognition Characters. The adult female is medium sized and has a long dark scaled proboscis. The scutum has a broad median stripe of dark bronze brown scales which is bordered with greyish white to yellowish scales. The first abdominal tergite is largely pale scaled; the remaining tergites are dark purplish on the dorsum. The front and middle femora are dark scaled with the posterior surface being pale; the basal half of the hind femur is pale on all aspects and is dark apically. The front and middle tibiae and tarsi are dark scaled.

Bionomics. The larvae may be found in temporary rain pools following prolonged rains. The females are fierce biters attacking man any time during the day in shady areas (Anonymous, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in southeast United States north to Ohio and Pennsylvania and west to Nebraska and Texas (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Atchison and Riley counties by DeMoss (1937); from Cowley, Labette, Montgomery and Sedgwick counties by Beadle (1944); from Bourbon, Cloud, Douglas, Geary and Leavenworth counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Psorophora (Psorophora) howardii Coquillett

Psorophora howardii Coquillett, 1901, Can. Ent., 33:258. Synonomy:

Psorophora virescens Dyar and Knab (Carpenter and LaCasee, 1955).

Recognition Characters. The adult female is very large and has a long brown proboscis. The scutum has a narrow median stripe of dark bronze scales and black setae, a submedian stripe of similar scales and a large lateral area of white scales on both sides. The first abdominal tergite has a broad median patch of white scales; the remaining tergites are blue-black scaled dorsally and with white scales laterally and apically. The femora are yellow scaled and speckled with dark scales; the tibiae are clothed with yellow and purple scales.

Bionomics. The larvae may be found in temporary rain filled pools and are predaceous on other mosquito larvae with which they are associated. The adult female is a persistent biter attacking man any time during the day when their breeding grounds are invaded.

Medical Importance. It is not known to be of medical importance.

Distribution. It is found primarily in the southeastern United States.

Kansas Distribution. It has been reported from Saline county by Olson and Keegan (1944); from Labette county by Beadle (1944); from Allen and Bourbon counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Psorophora (Janthinosoma) longipalpis Roth

Psorophora (Janthinosoma) longipalpis Roth, 1945, Proc. Ent. Soc. Wash., 47:1. Aedes horridus (Dyar and Knab), (in part), Psorophora horridus Howard, Dyar, and Knab, (in part), Psorophora (Janthinosoma) horridus Matheson, (describes male), Psorophora (Janthinosoma) horrida Rozeboom, (describes larvae) (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is medium sized and has a long dark probosois. The scutum has a broad median strips of dark bronze brown scales which is bounded laterally with broad white to yellowish scales and narrow pale scales intermixed with the broad ones on the posterior third of the scutum. The first abdominal tergite has yellowish white scales; the remaining tergites are violet scaled dorsally. The front and middle femora are dark with the posterior surfaces being pale; the hind femur has the basal two-thirds pale on all aspects. The tibias and tarsi of the front and middle legs are dark scaled.

Bionomics. The larvae can be found in heavily shaded temporary rain filled pools (Carpenter and LaCasse, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in the midwestern United States.

Kansas Distribution. It has been reported from Atchison county (Anonymous, 1951) and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Psorophora (Grabhamia) signipennis Coquillett

Taeniorynchus signipennis Coquillett, 1904, Proc. Ent. Soc. Was., 6:167.

Recognition Characters. The adult female is medium sized and has a dark scaled probosois which has a very wide whitish yellow median band. The scutum is clothed with golden brown scales which are paler yellow on the sides. The first abdominal tergite has a median white scaled area; the remaining tergites are primarily white scaled and speckled with dark scales. The femora and tibias are dark speckled with pale scales mostly on posterior surface.

Bionomics. The larvae may be found in temporary ground pools, roadside pools and in recently filled pools in dried stream beds (Carpenter and LaCasse, 1955). The adult may be annoying when their breeding grounds are invaded (Anonymous, 1951).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in central United States.

Kansas Distribution. It has been reported from Dickinson, Doniphan, Hodgeman and Saline counties by DeMoss (1937); from Cowley, Montgomery, Labette, Riley and Sedgwick counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Butler, Crawford, Ellis, Ellsworth, Finney, Geary, Leavenworth, McPherson, Neosho, Pratt, Republic, Rice, Rush, Seward and Shawnee counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Genus Uranotaenia. This genus is composed of three species: syntheta which is found in Mexico and southwestern United States, anhydor which occurs in California and sapphirina occurring in eastern United States west to North Dakota and New Mexico which includes Kansas (Carpenter and LaCasse, 1955). It is separated from the other genera in that the second marginal cell is less than half as long as its petiole.

The eggs are laid in boat shaped masses on the surface of the water; the larva has a siphon tube of short or medium length with the anal segment completely ringed by the dorsal saddle.

Uranotaenia sapphirina (Osten Sacken)

Aedes sapphirinus Osten Sacken, 1868, Trans. Amer. Ent. Soc., 2:47.

Synonomy: Uranotaenia coquilletti Dyar and Knab, 1906, Jour. N. Y. Ent.

Soc., 14:186.

Recognition Characters. The adult female is very small and has a long dark brown proboscis. The scutum is clothed with golden to dark brown scales and a narrow median line of iridescent bluish scales extending nearly the entire length. The abdominal tergites are clothed in brown scales with the apices of the third, fifth and often the sixth tergite having a rounded median patch of white scales. The legs are dark brown scaled except for small patches of bluish white scales at apices of femora and tibiae and yellowish scales on the posterior surface of the femora.

Bionomics. The larvae may be found in permanent pools, ponds and lakes which contain floating or emergent vegetation exposed to sunlight. It is not known if the adult feeds on man (Carpenter and LaCasse, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in eastern United States west to North Dakota and New Mexico (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Ft. Leavenworth, Ft. Riley and Saline county by Olson and Keegan (1944a); from Cowley, Labette, Montgomery, Sedgwick and Shawnee counties by Beadle (1944); from Allen, Anderson, Barton, Bourbon, Ellsworth, Geary, Leavenworth, Neosho, Republic, and Rice counties (Anonymous, 1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Tribe Toxorhynchitini. This tribe is composed of a single genus Toxorhynchites. The tribe is separated from the other tribes by having the proboscis thickened basally and curved downward and backward.

The adults are large, brilliantly colored, diurnal and non-bloodsucking mosquitoes.

Genus Toxorhynchites. This genus consists of two species rutilus rutilus found in extreme southeastern United States and rutilus septentrionalis which are found in eastern United States north to New Jersey and Pennsylvania and west to the great plains of Kansas, Oklahoma and Texas (Carpenter and LaCasse, 1955).

The females of the two species are indistinguishable but the males may be separated by the coloration of the front tarsus; rutilus rutilus has the front tarsus with segment 2 and basal part of segment 3 with white scales, while rutilus septentrionalis front tarsus is entirely dark scaled (Carpenter and LaCasse, 1955). The larvae of the two species are indistinguishable, are found in rot cavities of trees and various types of woodsn artificial containers. The eggs which are laid singly on the surface of the water are ovate in shape (Carpenter and LaCasse, 1955).

Toxorhynchites rutilus septentrionalis (Dyar and Knab)

Megarhinus septentrionalis Dyar and Knab, 1907, Jour. N. Y. Ent. Soc., 15:12. Synonomy: Megarhinus herriokii Theobald, and Toxorhynchites rutilus septentrionalis Jenkins (Carpenter and LaCasse, 1955).

Recognition Characters. The adult female is a very large brilliantly ornamented mosquito which is indistinguishable from T. rutilus rutilus. The sides, and a median stripe which covers the anterior two-thirds of the scutum, are gold scaled with blue reflection; the remainder of the scutum is clothed with dark purplish brown scales. The abdominal tergites are clothed with brown to metallic blue green scales. The femora are dark brown, except the basal portion and posterior surface which is golden yellow. The tibiae are clothed with dark brown and purple scales.

Bionomics. The larvae are found principally in rot cavities of trees and occasionally in artificial containers. The females feed on the nectar of flowers and other plant juices (Carpenter and LaCasee, 1955).

Medical Importance. It is not known to be of medical importance.

Distribution. It is found in eastern United States north to New Jersey and Pennsylvania and west to the great plains of Kansas, Oklahoma, and Texas (Carpenter and LaCasse, 1955).

Kansas Distribution. It has been reported from Douglas county by DeMose (1937); from Cowley county by Anonymous (1951); and from the Arkansas White-Red river basin by McNeel and Ferguson (1954).

Control of Mosquitoes

Mosquito control is conveniently divided into permanent and temporary methods. Permanent methods are designed to eliminate or effectively control the water in which mosquitoes breed. Temporary control measures are used to obtain immediate relief from mosquitoes and during the period of instituting permanent control. Permanent measures should not be undertaken without the advice or consultation of a trained entomologist or sanitary engineer. The initial high cost of instituting permanent control measures must be weighed against the application of insecticides, a temporary type, on a scheduled basis.

Permanent control measures may be exercised by improving natural drainage, stream flushing, proper shoreline maintenance of impounded water, control of aquatic vegetation, control of rainfall and floodwater, control of coastal marshes and introducing certain species of fish. One or a combination of these control methods may have to be used to obtain satisfactory

control.

The three general methods of temporary control of mosquitoes are by application of larvicides, residual sprays, and space sprays.

Larvicides. This is accomplished by treating water surfaces with an insecticide to kill the mosquito larvae. DDT is usually the insecticide of choice, but if the mosquitoes prove to be resistant, other insecticides may be used such as lindane, dieldrin or toxaphene at the dosage recommended on the label. Solutions, emulsifiable concentrates, water dispersible powders, or dusts, if heavy vegetation or possible damage to crops may occur, may be used for effective larvae control. DDT at 0.2 of a pound per acre in a draining area, or 3.0 pounds per acre in a non-draining area for long residual effect and the danger of injuring wildlife does not exist, will generally give effective control (Anonymous, 1956). Effective control by airplane may be achieved by using 20% DDT oil spray at the rate of 0.2 of a pound of DDT per acre (Anonymous, 1956).

Residual Sprays. This type of spray is used to control the adults when they land on a surface. The common insecticide in use is DDT at the rate of 200 mg per square foot, or dieldrin at 25 to 50 mg per square foot and BHC at 20-25 mg per square foot also may be used (Quarterman, 1957).

Space Sprays. The most commonly used product indoors is a self-propellent aerosol known as an aeroeol bomb, which will provide limited protection, but a mixture containing 0.1 to 0.2 per cent pyrethrins may be used in various types of sprayers. The outdoor space sprayers will vary from very small portable units to large airplanes and helicopters. The most common unit, which is designed for residential areas and dense vegetation, is a fog generator which gives satisfactory control, unless high winds occur,

for at least twenty-four hours. The mist blower, which will give more satisfactory control over a longer period of time through its deposit of insecticide on various objects, has the disadvantage of covering automobiles and windows with a film of oil and insecticide. DDT is most commonly applied as a 5 per cent solution at 0.5 of a pound per acre (Quarterman, 1957), but it will depend on the area which is to be covered. Malathion may be substituted when resistance to the chlorinated insecticides occur.

Personal Measures. Repellents may be used for protection when entering areas which have high populations of mosquitoes. There are various brands of repellents, which are applied to the skin and/or clothing, but the repellent containing diethyltoluamide is proving to be more effective against a larger number of insects than the others on the market (Gilbert et al., 1957).

General Precautions. The directions and precautions which appear on the label of various insecticides should be strictly followed to insure the safety of all concerned and for effective control of insects.

TABANIDS (TABANIDAE, DIPTERA)

Family Tabanidae

The taxonomic characters which separate the family Tabanidae from the other families of Diptera are antennae composed of five or fewer freely articulated segments, tarsi with three pads, third antennal segment annulated, large and conspicuous calypters, and veins R four and R five are divergent enclosing the wing tip.

The tabanids, commonly called horse flies and deer flies, are composed

of a great number of species; Philip (1947) reported 475 species in 27 genera exclusive of subspecies and subgenera.

The adults are of stout build, strong fliers and have large, prominent and usually brilliantly colored eyes. The females, normally in the fall, lay their eggs in a cluster on vegetation, rocks or other material in an aquatic or semiaquatic environment. The larvae hatch, after several days, and burrow into the moist soil and feed on various organic material; some species are predaceous and feed on earthworms, snails, insect larvae and in dense populations will feed on one another (Hays, 1956). The larvae molt several times (4-9 depending on the author) during their development which may last as long as four or five months, and after their last molt migrate to relatively dry soil and go into a quiescent or pupa stage. The adults emerge from the puparian and make their way to the surface before their wings are fully expanded (Hays, 1956). The adult female which is diurnal in habit, feeds on various warm blooded animals, mates and deposits her eggs, while the male feeds chiefly on pollen and nectar. In the process of feeding the female tears or rips the skin of the animal and sucks up the exuded blood in a few minutes and sometimes makes several more punctures for no apparent reason (Philip, 1931).

Nearly all tabanids have the same general life cycle, with slight variations, that is, of the female depositing her eggs on vegetation near the water, the larvae after hatching burrow into moist soil, then migrating to relatively dry soil and pupating; the adult emerges, mates, seeks a blood meal, and then deposits her eggs. In recent studies by various authors it has been shown that T. quinquevittatus larvae have been found in pasture sod without the presence of nearby water, the only water available being from

natural rainfall.

The tabanide are second only to mosquitoes in their medical importance. The female ie, as in the mosquitoes, the sex whioh is of medical importance. The female may be distinguished by being dichoptic whereas the male is holoptic. The role played by the tabanids in transmission of various diseases is purely mechanical and is not necessary to the continuation or multiplication of the disease. When in the aot of feeding the female penetrates the ekin and will cause the wound to bleed profusely, possibly with some anticoagulant eecretion in her ealiva. If the animal were infeoted it would be possible for the tabanid to transmit the organism by way of contaminated mouth-parts, to an uninfeoted animal the next time she fed or when piercing the skin for the joy of it. It has been shown by various authors that tabanids are capable of transmitting anthrax, equine infectious anemia, equine encephalomyelitis, anaplasmoeis, sura, tularemia (deerfly fever), loiasie and el debab. In addition to the dieeases directly attributed to the tabanids, they may provide a portal of entry for various other oausative agents of disease. The blood exuded from the wound caused by the tabanid or a wound oaused by the animal kicking at the tabanid is an attractant to the screwworm, Callitroga americana C. & P. There are other ways of oausing lose to man by the attack of the tabanids; one ie to deny man access to various areas because of the constant and persietent attacks of the tabanids; the annoyance oan be great enough on cattle or other livestock to cause them to go off feed which would result in a failure to gain weight at a normal expeoted rate, and the injury to animale when running through fences or other obstacles in an attempt to eecape the bitee of the tabanids.

Ths family Tabanidae ie divided into two subfamilies, Pangoniinae Loew

and Tabaninae Loew. These two subfamilies are easily distinguished in that Pangoniinae has two apical spurs, usually strong, on the hind tibiae and Tabaninae lacks these spurs. The Pangoniinae are usually referred to as deer flies and Tabaninae, horse flies.

Subfamily Pangoniinae. This subfamily is separated into three tribes: Pangoniini Enderlin which has 7 annuli in the flagellum; Chrysopini Enderlin which does not have over 5 divisions in the flagellum (4 annuli); and Merycomyia which has only 2 annuli on the third antennal segment. The tribe Merycomyia Hine is rare and is not found in Kansas.

Tribe Pangoniini. This tribe has only one genus represented in Kansas, which is Esenbeckia. The genus can be distinguished by the hyaline or diffusely tinted wings, proboscis about equal to height of head and not swollen basally, and cell R five closed and petiolate.

Tribe Chrysopini Enderlin. This tribe is represented in Kansas by two genera, Silvius and Chrysops. Silvius Meig. can be distinguished by its hyaline wings or isolated clouds on the cross veins, the eyes "freckled" with small rounded spots, and the flagellum longer than the 2 basal segments combined. Chrysops Meig. can be distinguished by having a slender abdomen, wings having mostly irregular dark patterns, and the eyes with large angular spots.

Key to Subfamily Pangoniinae Found in Kansas - Adult Female. Adapted from Philip (1947) and Brennan (1935).

1 Hind tibiae with two apical spurs ..... Subfamily Pangoniinae..2

1' Hind tibias without apical spurs ..... Subfamily Tabaninae

2 Flagellum with at least 7 annuli ..... Tribe Pangoniini
Genus Ensenbeckia with only one species reported from Kansas, Ensenbeckia incisuralis (Say)

2' Flagellum with 4 annuli ..... Tribe Chrysopini..3

3 Eyes "freckled" with small round spots, flagellum longer than 2 basal segments combined, and wings hyaline or with isolated clouds on cross veins ..... Silvus Meig...4

3' Eyes with large angular spots and wings with irregular dark patterns ..... Chrysops Meig...5

4 Veins R four and R five with subapical spots ..... quadrivittatus (Say)

4' Veins R four and R five without subapical spots ..... pollinosus Will.

5 Apical spot on wing rather narrow, at most only includes extreme apex of cell R four 6

5' Apical spot includes at least one-half of cell R four 7

6 Black triangle encroaches upon yellow or gray on each side of central spot on second abdominal segment. Apex of cell M three often hyaline ..... aestuans Wulp or aestuans abaestuans Philip

6' Black triangle not encroaching upon yellow on each side .. callida O.S.

7 Apex of hyaline triangle not extending beyond vein M one .. moecha O.S.

7' Apex of triangle extending beyond vein M one 8

8 The yellow of the abdomen has 4 more or less complete brown or black longitudinal stripes 9

8' Without 4 longitudinal stripes on yellow abdomen 13

9 Apex of hyaline triangle very little beyond vein R four plus five .. 10

9' Apex of hyaline triangle extends at least to R two plus three 11

10 The mesonotum is dark brown and has two yellow-green stripes ..... aberrans Philip

10' The mesonotum is black and has four yellow lines and yellow hairs .. vittata Wied.

11 Lateral abdominal stripes not appearing on segments I and II ..... pikei Whit.

11' Lateral abdominal stripe complete 12

12 Frontal callus black ..... sequax Will.

12' Frontal callus yellow ..... beameri Brennan

13 Antennae distinctly swollen 14

13' Antennae rather slender 16

14 Vertex at least as broad as long ..... fulvaetra O.S.

14' Vertex longer than head 15

15 Abdomen light brown pattern obscure ..... brunnea Hine

15' Abdomen more yellowish pattern distinct ..... flavida Wied.

16 Abdomen fuscous or black with a conspicuous yellow mid-dorsal stripe .. .. wiedemanni Krober

16' Abdomen not so patterned ..... flavida Wied.

Ensenbeckia incisuralis (Say)

Pangonia incisuralis Say, Jl. Acad. N. S. Phil., III, 31, 1823. Synonomy: Pangonia inciea Wiedemann and Ricardoa latiflagrum Enderlein (Philip, 1947).

Recognition Characters. The mesonotum is fuscous and has yellow pubescence, the pleurae and venter are fuscous and have yellow pilosity. The female is 14-16 mm long. The abdomen is fuscous; the hind margins of all segments and the sides of the first two are yellow, the yellow pubescence being most dense on the hind margins; venter mostly fuscous, the segments with yellow hind margins. The wings are subhyaline and have a yellow tinge which is most saturated in the costal region; the veins are yellow and a stump is usually present at the bifurcation of vein R 4 plus 5. The legs are yellow and have yellow hairs except the front coxae and basal portion of the femora which are fuscous.

Distribution. It is found in Arkansas, Kansas, Oklahoma, Texas, New Mexico and Arizona (Philip, 1947).

Kansas Distribution. It has been reported from Chautauqua and Cowley counties (Brennan, 1935); from the Arkansas White-Red river basin (Anonymous, 1955); and from Riley county (KSC).

Silvius pollinosus Williston

Silvius pollinosus Williston, Trans. Conn. Acad. Arts Sci., 4:244, 1880.

Recognition Characters. The length of the female is 9-10.5 mm. The mesonotum has rather faint alternate light and dark stripes. The abdomen has an obscure double row of median black angulate spots which are more visible on segments II to IV. All pilosity and pubescence are white. The wings are hyaline and have a brown stigma and brown spots at the cross veins and bifurcation of vein R 4 plus 5. The legs are yellow except the gray pollinose front coxae and the joints, apices of tibiae, front and middle femora, practically the entire hind femora and all tarsi, except the yellow bases of the metatarsi are fuscous.

Distribution. It is found in Arizona, Colorado, Nebraska, New Mexico, Oklahoma, South Dakota, Utah and Wyoming (Philip, 1947).

Kansas Distribution. It has been reported as being found in Kansas from June to August by Brennan (1935); from the Arkansas White-Red river basin (Anonymous, 1955); and from Comanche, Riley, Russell and Seward counties (KSC).

Silvius quadrivittatus (Say)

Chrysops quadrivittatus Say, Jl. Acad. N. S. Phil., III, 33, 1823.

Recognition Characters. The female is 7-10 mm long. The mesonotum is yellow-gray pollinose with alternate light and dark stripes. The abdomen is yellow-gray or gray pollinose and has four rows of black vittate spots. The gray venter of the abdomen has a faint suggestion of a dark broken median and lateral stripe. The wings are hyaline and have a brown stigma and brown spots. The legs are yellow except for gray pollinose on the front coxae and the fuscous trochanters, apices of femora and tibiae, and tarsi except the

yellow bases of the metatarsi.

Distribution. It has been reported from Arizona, California, Colorado, Idaho, Minnesota, Montana, Nebraska, Nevada, New Mexico, Oklahoma, South Dakota, Texas, Utah and Wyoming (Philip, 1947).

Kansas Distribution. It has been reported from Kansas by Brennan (1935); from the Arkansas White-Red river basin (Anonymous, 1955); and from Pottawatomie, Jefferson, Clark, Reno, Riley and Seward counties (KSC).

Chrysops aberrans Philip

Chrysops aberrans Philip, Proc. Ent. Soc. Wash., 43:122, 1941.

Recognition Characters. The over-all length of the female is 9-11 mm. The mesonotum is dark brown with two yellow-green stripes. The fore coxae are yellow, mid and hind coxae are dark. The abdomen is yellow and has four dark stripes. The venter is yellow and has median and lateral dark stripes.

Distribution. It is found from Massachusetts to Pennsylvania, and west to Minnesota and Illinois (Philip, 1947).

Kansas Distribution. It is reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Chrysops aestuans Van der Wulp

Chrysops aestuans Van der Wulp, Tijdsch. v. Ent., 10:135, 1867. Synonomy: Chrysops moerens Walker (Hays, 1956).

Recognition Characters. The female is about 10-11 mm long. The mesonotum has four greenish gray stripes, with the median stripes converging behind the head. The legs are black. The abdomen has light triangles on at least segments 2 to 4; all segments are posteriorly margined with yellow and segments 1 and 2 have sublateral pale spots which occasionally extend

laterally into segment 3. The venter is gray.

Distribution. It has been reported from the Midwest and the western United States (Philip, 1947).

Kansas Distribution. It has been reported to occur in the Arkansas White-Red river basin (Anonymous, 1955a) and in Meade county (KSC).

Chrysops aestuans abaestuans Philip

Chrysops aestuans abaestuans Philip, Proc. Ent. Soc. Wash., 43:121, 1941.

Recognition Characters. The holotype female is 8.5 mm long. It differs from the characteristic C. aestuans in the breadth of the apical spot of the wing and the reduction of the lateral triangles on the second abdominal tergite.

Distribution. It has been reported from Iowa, Kansas, Colorado and South Dakota (Philip, 1947).

Kansas Distribution. It has been reported from Clark county by Philip (1941) and from the Arkansas White-Red river basin (Anonymous, 1955a).

Chrysops beameri Brennan

Chrysops beameri Brennan, U. Kans. Sci. Bull., 22:265, 1935.

Recognition Characters. The female is 8 mm long. The mesonotum, the pleural and the sternal regions are yellowish pollinose and have fuscous stripes. The abdomen is yellow and has four fuscous longitudinal stripes; the venter is yellow and has a broad midventral brown stripe extending basally not beyond segment 2, and on each side there is a narrow stripe.

Distribution. It has been reported from Arkansas, Delaware, District of Columbia, Florida, Georgia, Illinois, Maryland, New Jersey, New York, North Carolina, Ohio and Massachusetts (Philip, 1947).

Kansas Distribution. It has been reported from Comanche county by Brennan (1935) and from the Arkansas White-Red river basin (Anonymous, 1955a).

Chrysops brunnea Hine

Chrysops brunnea Hine, Ohio State Acad. Sci. Spec. Papers, No. 5:34, 1903.

Recognition Characters. The mesonotum has four grayish stripes. The scutellum and the sternum are uniformly brown with the legs being light brown to yellow and the tarsi somewhat darker. The abdomen, which has no definite pattern, is broadly brown and darkened medianly on each segment. The venter of the abdomen is uniformly brown.

Distribution. It has been reported from New York to North Carolina and west to Texas and Kansas (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Chrysops callida Osten Sacken

Chrysops callida Osten Sacken, Mem. Boston Soc. Nat. Hist. 2:379, 1875.

Synonomy: Chrysops callidula Philip.

Recognition Characters. Over-all length of the female is 8-10 mm. The mesonotum is dark and has four light stripes; the median pair does not reach the scutellum which is uniformly dark. The pleurae are dark and have two light stripes. The legs are black except bases of tibiae and the mid- and hind tarsi. The dorsum of the abdomen is black and has a median row of yellow triangles.

Distribution. It is found in eastern and mid-western United States.

Kansas Distribution. It has been reported from the Arkansas White-Red

river basin (Anonymous, 1955a) and from Clark county (KSC).

Chrysops flavida Wiedemann

Chrysops flavida Wiedemann, Dipt. exot., 1:105, 1821.

Synonomy: Chrysops canifrons Walker and Chrysops guiterasi Brunetti.

Recognition Characters. The female is 8-10 mm long and has four yellow-gray stripes on the mesonotum. The legs are yellow; the tarsi and the apical half of the fore tibiae are tinged with brown. The abdomen is brown and has a mid-dorsal or row of yellow triangles; each tergite is banded posteriorly with yellow; and there are sublateral pale spots on tergites 1, 2 and occasionally 3. The venter is yellow and tinged with brown toward the apex.

Distribution. It has been reported from New York to Florida and west to Kansas, Oklahoma and Texas (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Chrysops fulvastra Osten Sacken

Chrysops fulvaster Osten Sacken, West. Dipt., p. 221, 1877. Synonomy: Chrysops coloradensis Bigot and Heterochrysops fulvaster Krober (Philip, 1924)

Recognition Characters. The female is 6-8 mm long. The mesonotum is brown or yellow-brown pruinose and has fuscous stripes. The pleurae and venter are gray-yellow pollinose and have brown stripes. The abdomen is yellowish or gray-yellow and has a black spot beneath the scutellum; the second segment has a median pair of oblique black spots which are sometimes nearly united at the anterior margin to form a geminate spot; the remaining segments are black with yellowish posterolateral angles and hind margins which expand

to form mid-dorsal triangles.

Distribution. It has been reported from California east to Minnesota and Oklahoma (Philip, 1947).

Kansas Distribution. It has been reported as collected in Kansas from 4 June to 26 July (Brennan, 1935) and from the Arkansas White-Red river basin (Anonymous, 1955a).

Chrysops moecha Osten Sacken

Chrysops moecha Osten Sacken, Mem. Boston Soc. Nat. Hist., 2:315, 1875.
Synonomy: Chrysope moechus Segal (Philip, 1947).

Recognition Characters. The female is 8-9 mm long. The mesonotum has a sublateral pale green stripe on each side. The pleura has alternating dark and light stripes. The legs are yellow except for the darkened apices of the fore tibiae and fore tarsi. The abdomen has the first tergite yellow except for a small median black rectangle posterior to the ecutellum. The second and fourth tergites are dark posteriorly with a yellow median line and sublateral yellow areas. The remaining tergum is usually dark.

Distribution. It has been reported from Maine to North Carolina and west to Kansas and Oklahoma (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Riley county (KSC).

Chryeops pikei Whitney

Chrysops pikei Whitney, Can. Ent., 36:205, 1904.

Recognition Characters. The female ie 7-8 mm long. The mesonotum is black and has four yellowish linee and scattered yellow haire. The pleura is alternately yellow and dark striped and has sparse yellow hairs. The

abdomen is yellow and has four black etripes, the lateral etripes fading on the first and second tergites and the mid-dorsal pair sometimes merging on the first tergite. The venter is yellow and has two lateral dark etripes and is tinged black apically.

Distribution. It has been reported from New York to Georgia and west to Texas to Nebraska (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Jefferson and Riley counties (KSC).

Chrysops sequax Williston

Chrysops sequax Williston, Trans. Kans. Acad. Sci., 10:133, 1887.

Recognition Characters. The female is 8-9 mm long. The mesonotum is dark brown; it has four yellow stripes and yellow hairs. The pleura has alternate yellow and dark brown bands and yellow hairs. The abdomen is yellow and has four black longitudinal stripes, the median pair narrowly converging on tergite 1, and the lateral pair extending the whole length. The venter is yellow with three dark stripes; the broad center etripe is present on all sternites and the narrow lateral etripes absent from the first sternite.

Distribution. It has been reported from Massachusetts to Georgia and west to Nebraska, Kansas and Colorado (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Meade, Riley and Trego counties (KSC).

Chrysops univittata Macquart

Chrysops univittata Macquart, Dipt. exot. nouv. peu connus, Sup. V, p. 36, 1855. Synonomy: Chrysops faeoipennis Macquart.

Recognition Characters. The female is 7-8 mm long. The mesonotum is black and has two light greenish yellow stripes. The pleura is alternately yellow and brown striped. The abdomen has a median yellow stripe bounded on each side with irregular black areas; the first tergite is completely yellow. The venter of the abdomen is yellow basally and black apically.

Distribution. It has been reported from Maine to Florida and west to Kansas and Nebraska (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Riley county (KSC).

Chrysops vittata Wiedemann

Chrysops vittata Wiedemann Dipt. exot., 1:106, 1821. Synonomy: Chrysops areolatus Walker and Chrysops lineatus Jaennicke.

Recognition Characters. The female is 7-10 mm long. The mesonotum is black and has four yellow linee and yellow hairs. The abdomen is yellow and has four dark stripes; the middle pair reachee the first tergite and the lateral pair usually fades on the second tergite. The venter is yellow and has three faint dark stripee.

Distribution. It has been reported from Maine to Florida and west to Kansas, Nebraska and Texas (Philip, 1947).

Kaneas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Doniphan and Pottawatomie counties (KSC).

Chrysops wiedemanni Krober

Chrysops wiedemanni Krober, Stetin. Ent. Zig., 87:267, 1926. Synonomy: Chrysops fraternus Krober and Chrysops obsoletus of authors (not Wiedemann) (Hays, 1956).

Recognition Characters. The female is 6-9 mm long. The mesonotum is black and has two indistinct light stripes. The pleura has alternately yellow and dark brown stripes. The abdomen is dark brown and has a light-colored median parallel-sided stripe. The venter is yellow basally and black posteriorly.

Distribution. It has been reported from Maine to Florida and west to Kansas and Nebraska (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Subfamily Tabaninae Loew. This subfamily, characterized by not having apical spurs on the hind tibiae, is separated into five tribes, Chlorotabanini Philip, Bolbodimyini Philip, Diachlorini Philip, Chrysozonini Philip and Tabanini End. (Philip, 1947). The only tribe represented in Kansas is Tabanini, which can be distinguished from the other four tribes by having the subepaulets with hairs like those on the costal vein and the flagellum with 5 divisions.

Key to the Subfamily Tabaninae found in Kansas - Adult Female, Adapted from Philip (1947) and Stone (1938).

1 Hind tibiae with two apical spurs ..... Subfamily Pangoniinae

1' Hind tibiae without apical spurs ..... Subfamily Tabaninae..2
Only tribe found in Kansas, Tribe Tabanini End.

2 Vertex with a distinct and denuded ocelligerous tubercle 3

2' Vertex without tubercle 4

3 Eyes bare and scutellum pallid ..... Leucotabanus Lutz
Only species occurring in Kansas, annulatus (Say)

3' Eyes usually pilose and scutellum usually dark ..... Hybomitra End.

4 Eyes brown or yellow, distinctly pilose, without callosities .....
..... Atylotus O.S.
Only species occurring in Kansas, bicolor (Wiedemann)

4' Eyes blackish when dried, female with a broad basal callosity 5

5 Erect hairs on antennae, including annuli, and palpi .... Anaoimas End.
Only species found in Kansas, dodgei (Whitney)

5' Without erect hairs on antennae, etc. ..... Tabanus Linn...6

6 Abdomen with both median and sublateral pale spots 7

6' Abdomen not so marked 15

7 Furcation with a distinct brown spot 8

7' Furcation without a distinct spot 9

8 Large brown maculations on wing, not confined to cross veins and furcation. Lateral abdominal spots confined to posterior segments and often joined to median triangles ..... venustus Osten Sacken

8' Wing and abdominal spots not as above ..... reinwardtii Wiedemann

9 Mesonotum yellow in color and without longitudinal stripes; conspicuous line formed by median abdominal line ..... fulvulus Wiedemann

9' Without above combination of characters 10

10 Eyes pilose ..... orbicallus Philip

10' Eyes bare 11

11 Costal cell hyaline; small dark species and frons widened above ....
..... eparus milleri Whitney

11' Brownish species; frons usually not widened and costal cell infuscated if less than 12 mm long 12

12 Costal cell hyaline; basal portion of third antennal segment rather short and broad; and a faint spot, a furcation ..... abactor Philip

12' Furcation not margined with brown; basal portion of third antennal segment rather elongate 13

13 Frons narrow, widened above ..... sackeni Fairchild

13' Frons moderate in width and with parallel sides 14

14 Pale markings of abdomen yellowish brown, the sublateral spots distinctly touching hind margins ..... sublongus Stone

14' Pale markings of abdomen grayish, the sublateral spots small and separated from hind margins ..... longus Osten Sacken

15 Abdomen unicolorous or tergites with narrow posterior pollinose bands 16

15' Abdomen not as above 21

16 Palpus reddish brown to white, or if dark reddish, wing hyaline and has dark costal cell and the body is 25 mm or more in length 17

16' Palpus dark brown to black 18

17 Wings hyaline, the costal cell dark brown ..... americanus Foreter

17' Wings uniformly dilute brown, the costal cell yellow ..... calens Linn.

18 Furcation without a distinct dark cloud; wing uniformly brown to black ..... atratus Fabricius

18' Furcation with a distinct dark cloud 19

19 Mesonotum pale ..... punctifer Osten Sacken

19' Mesonotum dark brown to black 20

20 Frons narrow, distinctly widened above; antennae mostly orange .... proximus Walker

20' Frons moderate in width, nearly parallel sides; antenna mostly black; and wings nearly black ..... nigrescens atripennis Stone

21 Abdomen orange brown, with a row of dark subquadrate spots on median area of abdomen ..... abdominalis Fabricius

21' Abdomen with a single median row of pale spots or with a stripe with or without pale lateral spots 22

22 Median row of pale spots not forming a parallel-sided stripe 23

22' Abdomen with a median row of pale spots forming a parallel-sided stripe, with or without sublateral spots or stripes 30

23 No spot on tergite 2, abdomen with distinct, median brown stripe ... . trimaculatus Palisot

23' Pale spot on tergite 2 sometimes faint 24

24 Pale spot on tergite 2 distinctly smaller than those on tergites 3 and 4; scutellum with distinct pale pile ..... molestus Say

24' Not as above 25

25 Furcation not margined with brown, or if faint spot present there is also a stump vein at furcation 26

25' Furcation distinctly margined with brown 27

26 Small, compact, not over 15 mm long, dark reddish brown, the pale abdominal triangles arising from narrow bands ..... nigripes Wied.

26' Not as above third antennal segment mostly red; abdominal triangles very faint; cell R five narrowed toward margin ..... calens Linnaeus

27 Fore tibia unicolorous or rarely the base brownish, with orange-black hair, the apex darker 28

27' Fore tibia bicolored 29

28 Cell R five closed or strongly narrowed apically ..... calens Linnaeus

28' Cell R five wide open ..... equalis Hine

29 Cell R five closed; anterior half of wing distinctly yellowish brown; frons very narrow, slightly widened above; femora black; pale abdominal triangles usually not so distinct as the larger black markings .....abdominalis Fabricius

29' Frons moderate in width; pale abdominal triangles distinct; middle femora brownish; wings nearly hyaline but for spots; cell R five narrowed toward margin but rarely closed ..... sulcifrons Macquart

30 Eye with a single purple band; frons nearly parallel-sided; annulate portion of third antennal segment usually longer than basal portion; costal cell colored, sometimes faintly 31

30' Two purple bands on eye; frons somewhat widened above; annulate portion of third antennal segment shorter than basal portion; costal cell hyaline as rest of wing ..... lineola Complex..33

31 Palpus, pleura, and costal cell deeply yellow .... quinquevittatus Wiedemann

31' Palpus white, pleura grayish 32

32 Coetal cell etrongly infuscated; frontal callus.... *fuscicostatus* Hine

32' Coetal cell usually strongly brownieh yellow; abdomen black laterally, the lateral spots evanescent ..... *mularis* Stone

33 Male 34

33' Female 37

34 Scutellum and thorax concolorous 35

34' Scutellum reddieh on posterior margin 36

35 Middorsal abdominal etripe chalky white ..... *lineola* Fab.

35' Middorsal and sublateral stripes yellow ..... *lineola*

36 Upper eye facete little differentiated, bare under hand lens; legs predominantly reddish ..... *lineola scutellaris* Wlk.

36' Upper eye facets much enlarged, plainly hairy; legs variable .... *vittiger schwardti* Philip

37 Scutellum and thorax concoloroue, dark ..... *lineola* Fab.

37' Scutellum reddieh on posterior margin; sublateral abdominal stripes marked irregular 38

38 Legs predominantly reddieh ..... *lineola scutellaris* Wlk.

38' Femora of at least fore and hind pair infuscated or cinerous .... *vittiger schwardti* Philip

Tribe Tabannini Enderlein. This tribe is characterized by having hairs on the subepaulets like those on the coetal vein and having five divieions on the flagellum. Philip (1947) separatee it into 10 genera; four and poeeibly five genera are represented in Kansas. The four genera are *Anacimas*, *Atylotus*, *Leucotabanus* and *Tabanus*; the fifth, which cannot be confirmed, was reported to occur in the Arkansas White-Red river basin (Anonymous, 1955a).

Genue *Anacimas*. This genue ie represented in Kansas by one speciee, *Anacimas dodgei* (Whitney). It can be separated from the other genera by

having bare eyes, lacking a tubercle on the vertex, having blackish eyes when dried, and having unusually erect hairs on the antennae, including annuli, and palpi.

Genus Atylotus. Only one species of this genus is represented in Kansas, Atylotus bicolor (Wiedemann). It can be distinguished by having yellow or brown eyes which are distinctly pilose, by the absence of a tubercle on the vertex, and by having a normal flagellum with four distinct annuli.

Genus Leucotabanus. This genus, which has only one species found in Kansas, Leucotabanus annulatus (Say), can be separated from other genera found in Kansas by a distinct tubercle on the vertex, having normal flagellum with four distinct annuli, and by the eyes being ostensibly bare, and the scutellum pallid.

Genus Tabanus. There are twenty-seven species of this genus found in Kansas. It can be separated from the other genera by having a normal flagellum with 4 distinct annuli, by not having a hook on the third antennal segment, without a tubercle on the vertex, without hair on the annuli, antennae, and palpi, and the eyes blackish when dried.

Genus Hybomitra. The validity of this genus occurring in Kansas is in question inasmuch as the species named as occurring, Hybomitra orbicalla, cannot be found in any reference consulted during this study.

Anaoimas dodgei (Whitney)

Tabanus dodgei Whitney, Canad. Ent., 11:37, 1879.

Recognition Characters. The female is 13-15 mm long. The mesonotum is dull brown and has a pair of bluish grey sublateral stripes and some gray

laterally. The pleurae, eternum and coxae are gray, and have white hairs. The abdomen ie brown and has a pair of eublateral light gray stripee which are about as wide as the median brown stripe; the posterior margin of each tergite has a fringe of ehort yellowish hair. The wings are hyaline; the costal cell and the etigma are yellowieh; and the veins are dark brown.

Dietribution. It has been reported from Nebraska and Oklahoma (Philip, 1947).

Kansas Dietribution. It has been reported from Pottawatomie county (Stone, 1938); from the Arkansas White-Red river basin (Anonymous, 1955a); and from Riley county (KSC).

Atylotus bicolor (Wiedemann)

Tabanus bicolor Wiedemann, Dipt. exot., 1:96. 1821. Synonomy: Tabanus fulvescens Walker, Tabanus ruficeus Macquart and Atylotus bicolor Osten Sacken (Hays, 1956).

Recognition Charactere. The female ie 10-15 mm long. The mesonotum is brown and has dense orange-yellow hairs. The legs are orange-yellow and have black hairs on femora and tibiae. The wings are hyaline, veins yellow and the costal celle are tinged with yellow. The abdomen ie variable, usually with dark epots and orange-yellow hairs, and the venter is uniformly light.

Distribution. It has been reported from Delaware, District of Columbia, Illinoie, Maine, Massachusetts, Michigan, Minnesota, New Jersey, New York, North Dakota, Pennsylvania and Wieconsin (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Norton county (KSC).

Leucotabanus annulatus (Say)

Tabanus annulatus Say, Jour. Acad. Nat. Sci. Phila., 3:32-33, 1823.

Recognition Characters. The female is 10-12 mm long. The mesonotum is reddish or orange brown; it has white pollen; yellowish-orange and white hair. The pleuras and eternum are whitish and have white hair. The wings are hyaline and have brown veins. The abdomen is reddish brown and the hind margins of the tergites are pale.

Bionomics. Lewis and Jones (1955) report that the larvae have been found from willow and elm tree holes, rotting logs, cavities in tree stumps, and holes in trees located from five to twenty-two feet above the ground.

Distribution. It has been reported from Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Missouri, New York, North Carolina and Texas (Philip, 1947).

Kansas Distribution. It has been reported from Kansas by Philip (1947) and from the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus abactor Philip

Tabanus abactor Philip, Ohio Jour. Sci., 36:153, 1936. Synonomy: Tabanus gracilis Sanborn, Stiles, and Moe (Not Wiedemann) (Stone, 1938).

Recognition Characters. The female is 12-15 mm long. The mesonotum is dull brown and has an indication of paler lines. The pleura, sternum and coxae are gray and have concolorous hair. The wings are hyaline and have a faint brownish spot at the furcation. The dull orange-brown abdomen has a median row of pale grayish triangles which usually reach the length of the tergites, and have oblique, sublateral spots which touch hind margin of the tergites; the venter is grayish brown and has a broad median darker stripe.

Bionomics. Schomberg (1955) reports the adult as being the chief transmitter of anaplasmosis, which is the most important disease of cattle in the United States. The larvae, which have been found in dry leaf-covered soil under trees, are white and show no typical markings and are very sluggish (Schomberg, 1955). In addition, Schomberg reported that the eggs from caged females were scattered on the sand floors of the cages and had an incubation period of about six days.

Distribution. Arkansas, Kansas, Oklahoma and Texas (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Barber county (KSC).

Tabanus abdominalis Fabricius

Tabanus abdominalis Fabricius, Syst. Antl., p. 96, 1805.

Recognition Characters. The female is 15-20 mm long. The mesonotum is brown to nearly black with distinct light brown to yellowish lines. The pleurae, sternum and coxae are grayish brown and have yellowish hairs. The femora are black, the tibiae are brown except the blackened apices of the fore tibiae, and the tarsi are dark brown to black. The wings are pale brown and darker along the veins with large spot at furcations. The abdomen is orange to orange-brown and has a dark median spot on each tergite and a row of median triangles posterior to the black spots. The venter is orange and tinged with black posteriorly.

Distribution. It has been reported from Arkansas, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Massachusetts, Michigan, Mississippi, Nebraska, New Jersey, Oklahoma, Pennsylvania and Texas (Philip, 1947).

Kansas Distribution. It has been reported to occur in the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus americanus Forster

Tabanus americanus Forster, Novas species insec., I:100, 1771. Synonomy: Tabanus plumbeus Drury, Tabanus ruficornis Fabricius, Tabanus limbatus Palsiot de Beauvois, Tabanus americus Mosier and Snyder, and Stigmatophthalmus americanus Enderlin (Hays, 1956).

Recognition Characters. The female is 23-28 mm long. The mesonotum is reddish purple and has faint lines of grayish pollen. The pleurae, sternum and legs are reddish purple to reddish brown and have yellow hairs. The wings are hyaline, the costal cells are dark brown and the veins are brown. The abdomen is reddish purple to reddish brown with wide bands of gray pollen on the posterior border of each tergite, both dorsally and ventrally.

Distribution. It has been reported from Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, New York, Pennsylvania and Virginia (Philip, 1947).

Kansas Distribution. It has been reported to occur in the Arkansas White-Red river basin (Anonymous, 1955a) and in Woodson county (KSC).

Tabanus atratus Fabricius

Tabanus atratus Fabricius, Syst. Ent. p. 789, 1775. Synonomy: Tabanus americanus Drury, Tabanus niger Palsiot de Beauvois, Tabanus validus Wiedemann, Stigmatophthalmus atratus Enderlein and Straba atrata Enderlin (Hays, 1956).

Recognition Characters. The female is 20-28 mm long. The thorax is blackish purple, occasionally with indistinct reddish lines. The wings are almost uniformly brown and the first posterior cells noticeably narrowed at the margin. The dorsum and the venter of the abdomen are blackish purple and occasionally have grayish pollen.

Bionomics. Philip (1931) reported the larval habitat as temporary ponds and running water. The larvae have been found in slow, moving or stagnant water, along banks of lakes and between a levee and the Mississippi River (Lewis, 1955).

Distribution. It has been reported from Massachusetts and Florida west to Idaho and New Mexico.

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a); and from Comanche, Dickinson, Franklin, Meade, Pottawatomie, Reno, Riley and Sherman counties (KSC).

Tabanus nigrescens atripennis Stone

Tabanus nigrescens atripennis Stone, Ent. Soc. Wash. Proc. 37:15-16, 1935.

Recognition Characters. The female is 24-26 mm long. It is black and structurally indistinguishable from the typical Tabanus nigrescens except that the wings are deeply smoky and only slightly paler posteriorly, if at all.

Distribution. It is found in Maryland, Florida, Texas, Oklahoma and Kansas (Philip, 1947).

Kansas Distribution. It has been reported to occur in the Arkansas White-Red river basin (Anonymous, 1955a) and in Meade and Pottawatomie counties (KSC).

Tabanus calens Linnaeus

Tabanus calens Linnaeus, Syst. Nat. ed. 12, 1(1767):1000. Synonomy: Tabanus giganteus DeGeer, Mem. pour servira l'hist. des ins., 6(1776):226; Tabanus lineatus Fabricus, Speciee Ins., 2(1781):445; Tabanus pallidus Paleiot de Beauvois, Ins. rec. en Afr. et en Amer., 1809, p. 100; Tabanus bicolor MacQuart, Dipt. exot. nouv. peu connus, Sup. V, 1847, p. 21; and Tabanus caesiofasciatus Macquart, Dipt. exot. nouv. peu. connus, Sup. V. 1855, p. 32 (Hays, 1956).

Recognition Characters. The female is 22-24 mm long. The mesonotum is dark brown, has indistinct lighter lines and patches of white hairs above wing base; the remaining dorsal hairs are black. The pleurae, sternum and coxae are reddish with gray pollen and white hairs. The legs are reddish brown and the tarsi and hind tibiae are darker. The wings are brownish with the first posterior cells narrowed apically.

Bionomics. Tashiro and Schwardt (1953) report that the egg masses contain between 300 and 400 eggs; each egg is yellow with an orange band around it. The larvae are cream colored, and when full grown measure from 16 to 30 mm. In the rearing studies by Tashiro and Schwardt the cannibalistic larvae had a growing period which varied from 22 to 24 months, followed by a pupal period lasting from 16 to 24 days.

Distribution. It is reported to occur in Michigan (Hays, 1956) and from Massachusetts to Florida and west to Texas and Oklahoma (Philip, 1947).

Kansas Distribution. It has been reported to occur in the Arkansas White-Red river basin (Anonymous, 1955a) and in Franklin county (KSC).

Tabanus equalis Hine

Tabanus equalis Hine, Ohio Jour. Sci. 23:205, 1923.

Recognition Characters. The female is 17-22 mm long. The mesonotum is dark reddish and has yellowish pollinose stripes. The pleura and sternum are pale reddish and have pale hair. The wings are hyaline and the cross veins and furcation are faintly margined with brown. The legs are nearly uniformly reddish and have nearly white hair. The abdomen is reddish brown and has a row of median, distinct pale triangles about equal in size on tergites 2-4, and progressively smaller posteriorly; the lateral posterior margins of each tergite have a narrow yellowish band; the venter is nearly uniformly reddish and has pale pollen.

Bionomics. Schomberg (1955) found adults occurring in Oklahoma from May 22 to August 12, being most abundant during the last of June and the first two weeks of July. The larvae are cylindrical, have dull yellow coloration, dark brown mandibles, and when full grown are about 34 mm long. The larvae have been found in seven localities all covered with low grass and shaded by elm trees (Ulmus americana L.) and with excellent drainage (Schomberg, 1955).

Distribution. It is found from Iowa south to Oklahoma and Alabama (Stone, 1938).

Kansas Distribution. It has been found in Jackson county (Stone, 1937); in the Arkansas White-Red river basin (Anonymous, 1955a) and in Coffey, Doniphan, Franklin, Riley and Russell counties (KSC).

Tabanus fulvulus Wiedemann

Tabanus fulvulus Wiedemann, Auss. zweifl. Ins., 1:153, 1828. Synonomy: Tabanus fulvofrater Walker and Tabanus mutatus Walker (Stone, 1938).

Recognition Characters. The female is 12-16 mm long. The mesonotum is black, tinged with yellow and covered with yellow hair, giving it an olive-green color. The pleuras, sternum and coxae are gray, tinged with yellow, and have pale yellowish hair. The wings are hyaline and the costal cells are tinged with yellow. The abdomen is orange brown, grading to black apically; it has three rows of orange yellow spots, the median row contiguous and widening posteriorly on each segment; the venter is yellowish and sometimes darker medianly.

Distribution. It is found in the Atlantic states and in Arkansas, Kentucky, Illinois, Louisiana and Missouri (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus fuscicostatus Hine

Tabanus fuscicostatus Hine, Ohio Nat. 7:24, 1906.

Recognition Characters. The female is 10-13 mm long. The mesonotum is blackish-brown and has brownish-gray lines. The remaining thorax is gray and has whitish hair. The wings are hyaline and the costal cell, veins, and stigma are brown. The abdomen is dark brown and has a median parallel-sided stripe of yellowish brown, and usually small sublateral spots of the same color; the venter is yellowish brown and dusky apically.

Distribution. It is reported from Kansas, Louisiana, Mississippi, North Carolina, South Carolina and Texas (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus lineola lineola Fabricius

Tabanus lineola Fabricius, Ent. Syst., 4:369, 1794. Synonomy: Tabanus vicarius Walker, Tabanus quinquemaculatus Hine, Tabanus compactus Aldrich and Tabanus quinquevittatus Hine (Hays, 1956).

Recognition Characters. The female is 10-15 mm long. The mesonotum is dark brown with gray pollen, and mixed dark and light hairs. The pleuras, sternum and coxae are gray with white hairs. The wings are hyaline and the veins are dark brown. The abdomen is brownish to black; it has a median parallel-sided yellow to whitish stripe, and oblique sublateral pale areas contiguous and forming irregular spots. The venter of the abdomen is yellowish-brown, tinged with black apically.

Bionomics. Lewis and Jones (1955) found the larvae, and that of closely related species, along the shores of lakes, in mud around edges of borrow pits and bayous, in banks of irrigation ditches; in swamps the larvae may be found under bark and in punky wood of floating logs, in debris and around cyprus trees; in rice fields around terraces and thick green scum, and under cow dung which was 150 feet from water.

Distribution. It is found in the Atlantic states and west to Kansas.

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a), and from Pottawatomie, Reno and Riley counties (KSC).

Tabanus linsola scutellaris Walker

Tabanus scutellaris Walker, Ins. Saund. Dipt., 1:27, 1850. Synonomy: Tabanus lineola scutellaris Stone and Tabanus linsola of authors (partim) (Hays, 1956).

Recognition Characters. The only differences from the typical T.

lineola is the posterior half of the scutellum being reddish brown and the hind femora reddish.

Distribution. It has been reported practically in every state (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Franklin, Pottawatomie, Reno, Riley and Russell counties (KSC).

Tabanus longus Osten Sacken

Tabanus longus Osten Sacken, Mem. Boston Soc. Nat. Hist. 2(pt. 4, No. 4 and sup.):447-448, 559, 1876-78.

Recognition Characters. The female is 13-15 mm long. The mesonotum is dark brown and has a mixture of black and white hair. The pleurae, sternum and coxae are gray and have white hair. The wings are hyaline. The abdomen is dark brown and has a median row of slender, evanescent, whitish spots, widened at the posterior margins, and sublateral, oblique spots of the same color not touching the posterior margin; the venter is grayish brown.

Distribution. It is found in Pennsylvania and North Carolina to Oklahoma (Stone, 1938).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a), and from Barber and Pottawatomie counties (KSC).

Tabanus molestus Say

Tabanus molestus Say, Jour. Acad. Nat. Sci., Philad., 3:31, 1823. Synonomy: Atylotus tenessensis Bigot (Stone, 1938).

Recognition Characters. The female ie 14-21 mm long. The mesonotum ie brownish and has dietinct whitieh lines. Ths pleurae, eternum and ooxae are gray and have whitish, brown, and brownish-black hair. The wings are subhyaline; the coetal ocll is brown; the furcations and oroes veins are very faintly margined with brown. Ths abdomen is a deep orange brown and has a median row of whitieh trianglee oonsieting of emall ones on the poeterior margin of eecond tergite, broad ones eometimee reaching antsrior margin on tsrgitee 3 and 4, and emaller onee poeteriorly. The hind margins of the tergitee usually have narrow whitish bande expanding laterally. The ventsr ie grayieh brown, and with paler bande apically.

Distribution. It ie found from New Jersey to Florida and west to Oklahoma, Kansas and Texas (Philip, 1947).

Kansas Distribution. It has been reported to oocur in the Arkaneas White-Red river basin (Anonymous, 1955a).

Tabanus mularis Stone

Tabanus mularis Stone, Ent. Soc. Wash. Proo. 37:15, 1935.

Recognition Characters. The female ie 10-12 mm long. The mesonotum is olivs green and unstriped. Ths wings are hyaline and the coetal oell ie orange-brown. The abdomen ie black and has a light yellowish gray median stripe and an indication of faint sublateral etripee; the venter is olive green.

Distribution. It is found in the southeaetern part of the Unitsd Statee, from Maryland to Florida and west to Oklahoma (Stone, 1938).

Kansas Dietribution. It has been reported from the Arkansas White-Rsd river basin (Anonymous, 1955a).

Tabanus nigripes Wiedemann

Tabanus nigripes Wiedemann, Dipt. exot., 1:75, 1821. Synonomy: Tabanus ooffeatus Macquart (Hays, 1956).

Recognition Characters. The female is 11-14 mm long. The mesonotum is dark reddish black, has stripes of grayish pollen and mixed yellow and whitish hairs. The pleurae, sternum and coxae are grayish, tinged with red and with whitish hair. The legs are reddish black and have mixed black and white hairs. The wings are hyaline and the veins are brown. The abdomen is reddish black and has a median row of white triangles extended to form white posterior borders of the tergites.

Distribution. It is found from Colorado to Massachusetts and south to Louisiana and Florida (Stone, 1938).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus orbicallus Philip

Tabanus orbicallus Philip, Canad. Ent. 68:157-159, 1936.

Recognition Characters. The female is 13-15 mm long. The mesonotum is gray and has an indication of paler stripes and a mixture of white, golden and black hair. The pleurae, sternum and coxae are yellowish brown and have long white hair (the pleura is partially grayish). The wings are hyaline. The abdomen is blackish and has a median row of slender gray triangles and large, oblique, yellowish-brown triangles at each side; the venter is yellowish brown and has some gray.

Distribution. It is found in Iowa, Kansas, Nebraska, Oklahoma and South Dakota (Stone, 1938).

Kansas Distribution. It has been reported from Grove and Nese counties

(Stone, 1938); from the Arkansas White-Red river basin (Anonymous, 1955a); and from Pottawatomie county (KSC).

Tabanus proximus Walker

Tabanus proximus Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, pt. 1, p. 147, 1848. Synonomy: Tabanus benedictus Whitney (Stone, 1938).

Recognition Characters. The female is 25-27 mm long. The mesonotum is dark reddish brown and has faint pollinose lines. The pleuras, eternum and coxae are dark and have black hair. The wings are pale orange-brown and are infuscated at cross veins and furcation; the costal cell and stigma are darker orange brown. The abdomen is nearly black and has thin grayish pollen dorsally.

Distribution. It is found in Illinois and Virginia to Oklahoma, Texas and Florida (Stone, 1938).

Kansas Distribution. It has been reported to occur in the Arkansas White-Red river basin. (Anonymous, 1955a).

Tabanus punctifer Osten Sacken

Tabanus punctifer Osten Sacken, Mem. Boston Soc. Nat. Hist. 2(pt. 4, No. 4): 453-454, 1876.

Recognition Characters. The female is 19-22 mm long. The mesonotum is dark reddish and is covered with creamy hair. The rest of the thorax is dark brown and has concolorous hair. The wings are brownish, paler posteriorly; the cross veins and furcation are distinctly margined with brown; and cell R five is distinctly narrowed apically. The abdomen is entirely black.

Distribution. It is found in western United States east to Oklahoma and Texas (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Riley and Russell counties (KSC).

Tabanus quinquevittatus Wiedemann

Tabanus quinquevittatus Wiedemann, Dipt. Exot. 1:84, 1821. Synonomy: Tabanus costalis Wiedemann, Tabanus vicarius Walker (partim), Tabanus baltimorensis Macquart and Tabanus floridanus Szilady (Hays, 1956).

Recognition Characters. The female is 11-14 mm long. The mesonotum is dark brown and has erect black hairs and recumbent yellow hairs. The pleurae, sternum and coxae are gray and have yellow hairs. The abdomen varies from black to orange brown, and has a parallel-sided middorsal yellow line bordered with black, which gives way to orange laterally.

Bionomics. Tashiro and Schwardt (1949) reported large numbers of larvae along banks of small pasture stream where the soil was damp but not wet.

Distribution. It is found from the Atlantic states to Kansas, Nebraska and South Dakota (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Pottawatomie, Riley, Stafford and Woodson counties (KSC).

Tabanus reinwardtii Wiedemann

Tabanus reinwardtii Wiedemann, Auss. Zweifl. Ins., 1:130, 1828. Synonomy: Tabanus erythrotaenius Walker (Hays, 1956).

Recognition Characters. The female is 15-19 mm long. The mesonotum is

blackish and has reddish lines and gray pollen. The pleurae and sternum are blackish tinged with red, and have gray pollen and white hairs. The wings are hyaline, the furcations and cross veins are distinctly margined with brown, and the first posterior cells are narrowed apically. The abdomen is reddish brown to almost black; it has a median row of pale tergites and sublateral gray spots in an obliqus pattern on all tergites. The venter is gray and is darkened mesially.

Bionomics. The larvae have been found along the water edges in muddy banks of various streams or ponds (Fairchild, 1950).

Distribution. It is found from the Atlantic states west to Colorado, Montana and Wyoming (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Pottawatomie and Riley counties (KSC).

Tabanus sackeni Fairchild

Tabanus sackeni Fairchild, Boston Soc. Nat. Hist. Occ. Papers, 8:141, 1934. Synonomy: Tabanus longus Osten Sacken (partim) (Hays, 1956).

Recognition Characters. The length of the female is 11-14 mm. The mesonotum is brown and has yellowish gray hairs; stripes are present, but indistinct. The pleurae, sternum and coxae are gray and have white hairs. The wings are hyaline. The abdomen is brown and has a parallel-sided median row of grayish triangles; each tergite has sublateral oblique oval yellowish spots. The venter is gray.

Distribution. It has been reported from the Atlantic states to Kansas and Oklahoma (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus sparus milleri Whitney

Tabanus milleri Whitney, Canad. Ent. 46:344, 1914.

Recognition Characters. It can be distinguished from the typical T. sparus only in fresh or relaxed specimens by the single broad purple band on the greenish eye (the typical T. sparus has a unicolorous eye). The female is 9-11 mm long. The mesonotum is blackish, it has indistinct gray lines and mixed black and orange-yellow hairs. The pleurae, sternum and coxae are gray and have whitish hair. The wings are hyaline. The abdomen is brownish-black and has indistinct median triangles. The posterior border of the tergites are light and encroach upon each tergite to form sublateral pale spots.

Distribution. It is found from New York to Florida, from the Gulf states to Oklahoma and Kansas and in Michigan (Philip, 1947).

Kansas Distribution. It has been reported to occur in the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus sublongus Stone

Tabanus sublongus Stone, U.S.D.A. Misc. Publ. No. 305, p. 74, 1938.

Recognition Characters. The female is 12-14 mm long. The mesonotum is black, it has brown hair, some brownish pollen and scarcely any stripes. The pleura, sternum and coxae are pale gray and have white hair. The wings are nearly hyaline; the costal cell is only faintly washed with orange; and the veins are orange brown. The abdomen is dark brown and has three rows of yellowish-brown spots; the median spots form a continuous slender line which widens abruptly at the posterior margin of each tergite; and the sublateral spots are rather large, oblique, and each is in contact with the hind margin of the tergites. The venter is orange brown and sometimes

clouded with darker color.

Distribution. It has been found in Maryland, Virginia, New York, Pennsylvania, Tennessee, Missouri, Arkansas, Kansas and Oklahoma (Stone, 1938).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus sulcifrons Macquart

Tabanus sulcifrons Macquart, Dipt. exot. nouv. peu connus, Sup. V, p. 33, 1855. Synonomy: Tabanus variegatus Fabricius, Tabanus teotus Osten Sacken and Tabanus exul Osten Sacken (Hays, 1956).

Recognition Characters. The female is 18-23 mm long. The mesonotum is dark reddish brown and has thin gray pollen. The pleuras, sternum and coxae are reddish gray and have yellowish hairs. The wings are subhyaline with the costal cells orange and the first posterior cells narrowed but not closed apically. The abdomen is orange-brown dorsally (darker apically) and has a median row of white triangles which are usually margined dark brown or black. The venter of the abdomen is orange-brown tinged with black.

Bionomics. Schomberg and Howell (1952) report the adult to be the most injurious horse fly in Oklahoma, with the emergence period from late June to peak in August and declining in September. The Oklahoma study showed that after examining thousand of samples of soil, sulcifrons was only taken once from moist soil; 255 larvae were taken from 37 different locations - the soil was from damp to dry, at a maximum depth of two inches below surface and most found in shaded dry wash gullies (Schomberg and Howell, 1952).

Distribution. It has been reported from the eastern portion of the United States to Kansas, Oklahoma, Nebraska and Texas (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Allen, Dickinson, Franklin, Marshall, Pottawatomie, Republic, Riley and Shawnee counties (KSC). It is the most important species of horse fly in Kansas.

Tabanus trimaculatus Palsiot de Beauvois

Tabanus trimaculatus Palsiot de Beauvois, Ins. rec. en Afr. et en Amer., p. 56, 1807. Synonomy: Tabanus aestuum Bosc(MS) by Macquart and Tabanus quiquelineatus Macquart (Hays, 1956).

Recognition Characters. The female is 15-18 mm long. The mesonotum is reddish brown, has lines of gray pollen, and grayish white and dark brown hairs. The pleurae, sternum and coxae are reddish brown, have light gray pollen and gray hairs. The wings are almost hyaline, the costal cells infuscated, and the furcations and cross veins are margined with brown. The dorsum of the abdomen is reddish brown and has prominent median white triangles on tergites 3 through 5. The venter is gray and has a broad brown median stripe.

Distribution. It is found in the eastern and midwestern states (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Riley and Pottawatomie counties (KSC).

Tabanus venustus Osten Sacken

Tabanus venustus Osten Sacken, Mem. Boston Soc. Nat. Hist., 2:444, 1876.

Recognition Characters. The female is 16-18 mm long. The mesonotum has gray pollen and pile and longitudinal stripes of brown pollen. The pleura and sternum are generally brown. The wings are nearly hyaline. The abdomen is dark brown to black; the first tergite has a small median white spot; tergites 2 to 6 have median white triangles which are widest on the third tergite and are smaller posteriorly; and a sublateral row of rather faint round pale spots on tergites 3 to 6. The venter is dark brown and has a row of pale spots on each side of a broad median dark stripe.

Distribution. It ie found in midwestern United States (Philip, 1947).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Tabanus vittiger schwardti Philip

Tabanus vittiger schwardti Philip, Psyche 49:29, 1942.

Recognition Characters. Philip (1942) reported that the male differs from T. lineola scutellaris in that it has a large head, with much-enlarged upper eye facets occupying fully three-quarters of the total eye area, and with more pronounced hairs. The fore femora and, to a lese extent, the hind and mid-pair are infuscated. The female differs only in infuscation of femora.

Distribution. It has been reported from Arkansas, Arizona, Texas, Mississippi, Florida, Georgia, Virginia, Washington, D. C., Maryland, Delaware, Massachusetts, Ohio, Michigan and Kansas (Philip, 1942).

Kansas Distribution. It has been reported from Montgomery and Kiowa counties by Philip (1942); from the Arkansas White-Red river basin (Anonymous, 1955a); and from Reno, Meade, Riley, Franklin, Pawnee, Pottawatomie and Wabaunsee counties (KSC).

Control of Tabanide

It is very difficult to get the insecticide through the soil or mud to the larvae or to kill the adult horse fly before it has bitten several times. The larvae are found buried in damp soil near various types of water, but may be found in pasture-type soil which is considerable distance from available water. The adults are strong fliers, bite vigorously and repeatedly in a rapid sequence, so that several severe and painful wounds are made.

Larvicide. It has been reported by several authors that the use of granulated formulation of 1 to 2.5 percent of dieldrin applied at the rate of approximately 0.3 pounds per acre gave up to 85 percent protection for a period of up to one year.

Adulticide. The recommended control measures on livestock (Anonymous, 1958) is to use pyrethrin at 0.05 to 0.1 percent plus a synergist of piperonyl butoxide at 0.5 to 1.0 percent as a wet spray every two to three days, or a daily mist spray by hand or with a treadle sprayer. The above treatment not only kills the adults but will act as a repellent. A new repellent containing "Tabutrex" is available for spraying on all types of cattle and will give very effective control when sprayed daily. For personal protective measures the use of repellents such as "Off" may give satisfactory results. In addition, general sanitation by draining unnecessary ground pools may give some desired results.

Precautions. Before undertaking horse fly control an entomologist should be consulted as to the safety of the insecticide and probable results expected. In the use of any insecticide the directions should be followed on the label to insure safety and satisfactory results.

BLACK FLIES (SIMULIIDAE, DIPTERA)

Family Simuliidae

The taxonomic characters which separate this family from the other families of the order Diptera are the broad wings with the posterior veins being weak, the costa ending at or near the wing tip, the absence of ocelli, the antennae being composed of more than 6 freely articulated segments, dark color, rarely over 5 mm in length, and having a hump-backed appearance with short, thick legs.

The members of this family, which are often called black flies or buffalo gnats, may be so annoying as to cause livestock to stop feeding and to deny man access to certain areas. In addition to their nuisance value, they have been incriminated in the transmission of onchocerciasis to man in equatorial Africa, central America and southern Mexico. They are considered a possible vector of tularemia in western United States and are known to spread a malaria-like disease of poultry caused by Leucocytozzon spp. (Nicholson and Mickel, 1950). The three proven vectors of the Leucocytozoon disease are S. vernustum Say, S. meridionale Riley and S. jenningsi Mall., all of which occur in Kansas.

The eggs of the black flies are deposited on aquatic vegetation, emergent branches and stones in streams. The larvae, which vary in color from gray to brown or black, are elongated and round in cross section; the head is strongly sclerotized and the remainder of the body is membranous. The immature stages are found clinging to submerged rocks, branches or other vegetation in water which has a definite current; they are incapable of swimming but loop along like geometrid caterpillars (Micholeon

and Mickel, 1950). The pupae are characterized by having a conspicuous pair of respiratory organs and a cocoon which is either an unorganized mass of silk filaments in which the pupae is embedded or a delicately woven case open at the anterior end and resembling a slipper or a wall vase (Nicholson and Mickel, 1950).

The males, which do not have fully developed mouth parts for piercing, are confined to feeding on plant juices. The black flies are considered to be weak fliers but have been found to migrate as far as 10 miles, and some writers report migrations of as much as ninety miles (Nicholson and Mickel, 1950).

Key to the Kansas Simuliidae - Adult Female (Adapted from Nicholson and Mickel, 1950).

1 Pedisulcus present (a furrow or groove present on the second tarsal segment); basal cell absent ..... Simulium..2

1' Pedisulcus absent or very indistinct; basal cell usually distinguishable ..... Cnephia mutata (Malloch)

2 Setae on the radius between the stem vein and the radial sector .... aureum Fries

2' Radius bare between the stem vein and the radial sector 3

3 Stripes present on mesonotum 4

3' Stripes absent on mesonotum 5

4 Five stripes on mesonotum ..... vittatum Zett

4' Three stripes on mesonotum ..... meridionals Riley

5 A row of setae on subcosta ventrally ..... venustum Say

5' Subcosta bare ventrally ..... jenningsi Malloch

Genus Cnephia. This group is characterized by having an unbranched radial sector, which may have a swollen tip at the junction of the costa; eleven segmented antennae; toothed or untoothed claws on the female;

microtrichia on the upper side of the basal section of the radius; a single row of hairs on the upper side of the distal portion of Rs; presence of a basal cell; simuous Cu two; and spiniform macrotriohia intermixed with bristle-like ones on costa. One member of this genus is represented in Kansas.

Cnephia mutata (Malloch)

Prosimulium mutatum Malloch, U. S. Dept. Agric., Bur. Ent. Tech. Ser. 26: 1-71, 1914. Synonomy: Eusimulium mutatum permutatum Dyar and Shannon according to Smart (1945).

Recognition Characters. The body and legs are brown in color. The mesonotum is covered with pale hair-like pile; ecutellum has dark upright setae which is mixed with pale setas on some specimens; postnotum is bare and shining; and the pleural area is brown and has mixed light and dark setae. The wings are smoky brown and have dark hair-like setas on the stem vein and base of costa. The hind tibiae have characteristic elongate spurs. The pilosity of the abdomen is pale, sparse and confined mostly to the terminal segments.

Distribution. It is reported from Illinois, Indiana, Missouri, New Jersey, Virginia, California, Idaho, Montana, Washington and Wyoming by Dyar and Shannon (1927); from Rhode Island and Massachusetts by Nicholson and Mickel (1950); and from Arkansas and Colorado (Anonymous, 1955a).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Genus Simulium. The members of this genus may be separated from the other genera by the following characteristics: simple unbranched radial sector; no basal cell; Cu two simuous; macrotriohia of costa bristle-like

intermixed with epiniform; basal section of the radius naked or with macrotrichia on upper side; and eleven segmented antennae. Five species of this genus occur in Kansas.

Simulium aureum Fries

Simulia aureus Fries, Monograph Simul. Suec., p. 16, 1824. Synonomy: Eusimulium pilosum Knowlton and Rowe, and Eusimulium utahense Knowlton and Rowe (Stains and Knowlton, 1943), and Simulium bracteatum Coquillett and others according to Smart (1945).

Recognition Characters. The female has a general golden appearance. The basal two segments of the eleven segmented antennae are light brown. The head and meconotum is densely clothed with golden pubescence, occasionally silvery; and the pleural area is brown and has pale tufts. The scutellum is brown, densely clothed with pale yellow upright and recumbent setae, and the postnotum is bare except for a few posterior yellow setae. The wings are clear and have pale hairs on the stem vein and base of costa. The legs are yellow except the middle and hind coxae, apices of the femora, tibiae and hind basitarsi which are black. The abdomen is densely clothed with golden to silvery pile.

Distribution. It occurs widely over North America according to Nicholson and Mickel (1950).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Pottawatomie county (KSC).

Simulium jenningsi Malloch

Simulium jenningsi Malloch, U.S.D.A. Bur. Ent. (Tech. Ser.) 26:41.

Recognition Characters. The basal two segments and the base of the

third of the antennae are pale brown. The mesonotum is glossy dark gray to black, slightly pollinose anteriorly and laterally, and has sparse, pale yellow, fine pubescence. The scutellum is shiny dark brown and has black upright setae. The legs are yellow for the most part and have a prominent silvery-white pollinose patch dorsally on all tibiae, those on the hind pair confined to the basal half. The abdomen has a sparse, pale basal fringe; the second segment is dark brown and has gray pollinose reflections laterally; segments three to five are opaque velvety black dorsally; and the terminal segments are shiny dark brown to black.

Distribution. It is reported from Louisiana, Virginia, Maryland, District of Columbia, Minnesota, South Carolina, North Carolina, Florida and Illinois (Malloch, 1914).

Kansas Distribution. It is reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Simulium meridionale Riley

Simulium meridionale Riley, Rept. Ent. Comm. Agric. 492-517. 1881.
Synonomy: Simulium occidentale Townsend, Simulium tamanlipense Townsend, and Simulium forbesi Malloch.

Recognition Characters. The basal two segments of the antennae are paler than the remaining segments. The mesonotum has gray pollinose; moderately covered with short, white, hair-like pile; and has 3 longitudinal stripes present which may be indistinct, the lateral stripe somewhat converging anteriorly. The scutellum is black and has upright and a few recumbent pale setae. The legs are dark brown, except the gray pollinose coxae and the black tarsi. The claws have a large thumb-like basal tooth. The abdomen is bluish gray except tergites two to five which are black.

Distribution. It is found in the midwestern United States and extending westward and southward (Nicholson and Mickel, 1950).

Kansas Distribution. It is reported from Douglas county (Dyar and Shannon, 1927); from the Arkansas White-Red river basin (Anonymous, 1955a); and from Riley, Stafford, Pottawatomie, Dickinson and Ottawa counties (KSC).

Simulium venustum Say

Simulium venustum Say, Jour. Acad. Sci., Phila., 3:28, 1829.

Recognition Characters. The antennae are dark brown except the basal two segments which are pale brown. The mesonotum is shining dark brown or black and has gray pollinosity. The scutellum is dark brown and has upright black setae and many recumbent, pale, hair-like setae. The legs are yellow for the most part. The abdomen has a pale basal fringe; the second tergite is silver pollinose laterally; segments three to five are opaque and velvety black; and the remaining segments, shining brown to black.

Distribution. It has been reported from Utah, Idaho, Colorado, California, Washington, Montana, Wyoming and Texas according to Staine and Knowlton (1943); and from Minnesota (Nicholson and Mickel, 1950).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a).

Simulium vittatum Zetterstedt

Simulium vittatum Zetterstedt, Ins. Lappan. Dipt., p. 803, 1835.

Recognition Characters. The head is gray, sparsely covered with white setae, and the antennae are black and have pale pilosity. The mesonotum is gray and has sparse white pilosity; there are five black to brown

longitudinal mesonotal stripes, with the median stripe being the longest and extending the entire length, while the submedian pair are shorter and located on the posterior half of the mesonotum, with the lateral pair spot-like, sometimes indefinite, and occurring mesally from anterior to posterior. The scutellum is black to dark brown, has gray pollinosity, and is clothed with long white setae. The wings are clear and the veins are pale; the veins at the base of the wings are slightly yellowed; and the hair-like setae on the stem vein and base of the costa are white. The legs are yellow and black and have gray pollinosity. The abdomen is gray; the second segment has a median black spot; segments three to seven have a posterior tridentate black cross band dorsally.

Distribution. This probably is the most cosmopolitan species in the entire family, since it has been collected from various states in each section of the United States with the exception of the southeastern states (Stains and Knowlton, 1943).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and from Riley county (KSC).

Control of Black Flies

The control of black flies is accomplished by either controlling the larvae or the adults. In order to achieve satisfactory control, accurate preliminary surveys should be made by trained personnel to insure at least partially satisfactory control.

Twinn (1952) reported 91 percent larval and 85 percent adult control when an area was sprayed twice, by a C-47 airplane, with DDT oil solution applied at the rate of one-quarter of a pound of DDT per acre; one

application will adequately control larvae but two are needed to control adults.

It has been reported by Twinn (1952) that DDT applied in fuel oil at the rate of one part DDT per ten million parts of water, maintained at point of application for 15 minutes practically eliminated black fly larvae for a distance of one hundred seventeen miles in a river in Canada. Twinn (1952) concluded that the larvae injest the silt upon which the DDT lodges.

The use of repellents such as "Off" are quite effective for personal protection against the attack of adult black flies.

BITING MIDGES (CERATOPOGONIDAE, DIPTERA)

Family Ceratopogonidae

The taxonomic characters which separate the family Ceratopogonidae from the other families of the order Diptera are the antennae, which are composed of fourteen segments; absence of ocelli; the costa ending at or near the wing tip; the wings more narrow than broad; the media forked; and the mouth parts fitted for piercing.

The members of this family are minute, rarely over 5 mm in length. This family has 20 genera, and of this number three genera - Culicoides, Lasiohelea and Leptoconops - will attack warm-blooded animals (Curran, 1934). The genus Culicoides is the only one known to be of medical importance in Kansas.

Genus Culicoides. This genus may be separated from the other genera by the presence of humeral pits on the mesonotum, 2 anterior radial cells, costa ending at about six-tenths to two-thirds of the wing length, and the

first tarsal segment at least twice as long as the second. Culicoides have been incriminated in the transmission, but not in the United States, of Mansonella ozzardi (Manson), Acanthocheiloneura perstuans (Manson), Dipetalonema streptocerca (Macfie and Corson) and various Onchocerca sp. Culicoides sp. is suspected of transmitting a virus infection, bluetongue of sheep and fowlpox. In addition, they are capable of rendering an area almost uninhabitable to man because of their annoyance and painful bite.

The larvae of Culicoides may be found in mud, sand and debris at the edges of ponds, springs, lakes and creeks, treeholes and slime-covered bark. The immature form swims with an eel-like motion and rests on twigs or bits of leaves. The larvae have been observed feeding by Foote and Pratt (1954) on decaying vegetation and associated protozoa, algae and other microorganisms. In Kansas, problems of biting Culicoides are often associated with breeding in overflows from sink drains, cess pools, etc. (Knutson, personal communication). It has been reported that low water temperature is favorable for larval development and oviposition apparently takes place in a shady locality. The pupa, which is dark in color, is found in the mud along the banks of various types of water habitats.

Key to Genus Culicoides Found in Kansas - Adult Female, Adapted from Foote and Pratt (1954).

1 Wings uniformly colored, without light or dark markings .... hieroglyphicus Malloch

1' Wings with two or more light spots 2

2 The 2nd radial cell and surrounding veins darker than rest of wing which has no distinct white spots or 2nd radial cell partly or entirely included in light spot ..... obsoletus (Meigen)

2' Wing with 2 or more light spots or 2nd radial cell entirely dark 3

3 Wings with light spots near margin only, the center brownish or greyish ..... biguttatus (Coquillett)

3' Pattern of light spots in center as well as margins 4

4 Mesonotum marked with many small dark spots ..... variipennis cmplx

4' Mesonotum marked with large longitudinal dark lines, these usually laterally connected 5

5 Three light spots present in cell R five. The latter two may be connected with obsolescent arc along anterior edge of wing .... stillifer (Coquillett)

5' Only two light spots present on R five, the distal one sometimes large and indistinct 6

6 Light spots not present on vein M one or two but two spots present in cells M one and M two ..... crepusculariis Mall.

6' Light spots present on vein M one and M two, only 1 spot present in cell M one and M two 7

7 Small distinct light spots near center of cell R five, the tip of the cell dark ..... guttipennis (Coq.)

7' A small but distinct light spot at tip of cell R five .... haematopotus Malloch

Culicoides biguttatus (Coquillett)

Ceratopogon biguttatus Coquillett, Proc. U. S. Nat. Mus. 23:604, 1901.

Recognition Characters. It is the only species that has only two distinct light spots on the wings. These spots occur near the anterior margin, one over the r-m cross vein and the other just distal of the radial cell; the remainder of the wing is light gray or brown. The mesonotum is brown and divided into three about equal areas, the central area has a dark median stripe and the lateral regions are somewhat darker. The scutellum is dull yellow and has a transverse row of ten small hairs. The eyes are distinctly separated at the vertex, and the frons and clypeus are yellowish brown. The proboscis is three-quarters as long as the palpi and the antennae is a little longer than the head. The abdomen is dull brown in color.

Distribution. It has been reported from Connecticut, District of Columbia, Illinois, Maryland, Massachusetts, New York, Oregon, Texas, Virginia, Florida, Georgia, New Jersey, Ohio, Pennsylvania and Vermont (Foote and Pratt, 1954).

Kansas Distribution. It has been reported from Shawnee county by Foote and Pratt (1954) and from the Arkansas White-Red river basin (Anonymous, 1955a).

Culicoides crepuscularis Malloch

Culicoides crepuscularis Malloch. Bull. Ill. State Lab. Nat. History 10: 303, 1915.

Recognition Characters. The second radial cell of the wing is entirely dark. The light spots of the wing lie mainly within the cells rather than on the veins; the remainder of the wing is brown. The last five segments of the flagellum are about one-third longer than the first eight.

Distribution. It has been reported from Arizona, California, Colorado, Georgia, Illinois, Maryland, Michigan, Minnesota, Montana, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, Virginia, Washington, Wyoming, Alabama, New Jersey, New York, Utah and Vermont (Foote and Pratte, 1954).

Kansas Distribution. It has been reported from Montgomery county by Foote and Pratt (1954) and from the Arkansas White-Red river basin (Anonymous, 1955a).

Culicoides guttipennis (Coquillett)

Ceratopogon guttipennis Coquillett, Proc. U. S. Nat. Mus. 23:603, 1901.

Recognition Characters. The apical third of cell R five on the wing

ie dark and has light epots in cells M one, M two, at the base of vein M one and the middle of vein M two; vein Cu 2 ie entirely dark. The thorax has a definite pattern consisting of large light spots on a dark background. The scutellum is yellow and has a broad brown central mark. The femora have preapical rings, all tibiae have a subbasal band of yellow, while the hind tibiae have a preapical band of yellow.

Bionomics. Foote and Pratt (1954) reported the larvae may be found in treeholee and were obeerved feeding on decaying vegetation and assooiated protozoa, algae and other mioroorganiems.

Distribution. It has been found in Arizona, Conneoticut, Illinoie, Louieiana, Maryland, Miseissippi, Ohio, Oklahoma, Texae, Virginia, Florida, Georgia, Miesouri and Vermont (Foote and Pratt, 1954).

Kaneas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a) and a queetionable epecimen in poor condition from Neosho county (KSC).

Culicoidee haematopotus Mallooh

Culicoidee haematopotus Malloch, Bull. Ill. State Lab. Nat. Hist. 10:302, 1915.

Recognition Characters. The wings have light epots with quite distinct bordere and appear evenly whitish againet a heavily pigmented background; there are two well-eeparated light spote in cell R five, one of which ie small and at the extreme tip of the cell, while the other ie a larger distinct spot juet distad of the second radial cell.

Dietribution. It has been reported from California, Colorado, District of Columbia, Georgia, Illinoie, Louieiana, Maryland, New Mexico, Nevada, Oklahoma, Texas, Florida, Michigan, New York, Ohio, Penneylvania,

Tennessee, Utah and Virginia (Foote and Pratt, 1954).

Kansas Distribution. It has been reported collected in Riley county by Foote and Pratt (1954) and in the Arkansas White-Red river basin (Anonymous, 1955a).

Culicoides hieroglyphicus Malloch

Culicoides hieroglyphicus Malloch, Bull. Ill. State Lab. Nat. Hist. 10: 297, 1915.

Recognition Characters. The last five segments of the flagellum are about equal to the first eight. The second segment of the palpi is shorter than the third which is moderately swollen and has small deep sensory pits. The wings are clear. The mesonotum has large distinct markings consisting of prescutellar spots, paired longitudinal dark markings extending to and surrounding the sensory pits, and a central vitta widening slightly behind the sensory pits and again with the prescutellar depression.

Bionomics. The larvae are usually found in areas of salt marshes (Foote and Pratt, 1954).

Distribution. It has been reported from California, Colorado, Nevada, New Mexico, and Oklahoma (Foote and Pratt, 1954); and from Montana, Arizona, and Arkansas by Root and Hoffman (1937).

Kansas Distribution. It has been reported from the Arkansas White-Red river basin (Anonymous, 1955a); and from Riley and Stafford counties (KSC).

Culicoides obsoletus (Meigen)

Ceratopogon obsoletus Meigen Syst. Beschr., 1:76, 1818. Synonomy: Culicoides obsoletus, Edwards, Ceratopogon sanguisugus Coquillett, Culicoides sanguisugus Malloch, Ceratopogon virtulus Coquillett, Culicoides hirtulus

Root and Hoffman and Culicoides biguttatus Jenkins according to Wirth (1951).

Recognition Characters. It is a small (1.0 to 1.5 mm), shining, poorly marked, brown species. The mesonotum is shining brown and without a definite pattern. The wings are practically bare, with the hair confined to the tip and may have two faint dark transverse bands. There is a continuous elongate white spot which occupies all of cells M and M two, a white spot covering at least apical half of second radial cell, and an elongated white spot occupying all of M one cell and joining the spot in cell M two over the base of vein M two. There are no light spots present on either vein M one or two. The legs are uniformly brown in color.

Bionomics. Root and Hoffman (1937) report it as very annoying and has a painful bite. Hill and Roberts (1947) found it most active during the evening hours in the sand dunes.

Distribution. It has been reported from California, Colorado, District of Columbia, Illinois, Indiana, Maine, Maryland, Massachusetts, Missouri, Montana, New Hampshire, New York, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Washington, Georgia, New Jersey, Vermont and Virginia (Foote and Pratt, 1954).

Kansas Distribution. It has been collected in the sand dunes in Reno county (Root and Hoffman, 1937).

Culicoides stellifer (Coquillett)

Ceratopogon stellifer Coquillett, U. S. Nat. Mus. Proc., XXIII:604, 1901.

Recognition Characters. The eyes are almost contiguous at the vertex. The frons and clypeus are cinnamon brown. The mesonotum is yellowish or gray pruinose with very dark brown lines, one along the anterior margin terminating about the pit, and the other along the lateral margin from

humeral angle to the base of the wing. The wings have light markings with quite distinct margins and are highly contrasted with the darkly pigmented wing. There is a large spot present in the middle of cell R five, which has an anterior projection which curves at the anterior edge of the wing toward apex.

Distribution. It has been reported from Alabama, Arizona, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Maryland, Michigan, Mississippi, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Utah and Virginia (Foote and Pratt, 1954).

Kansas Distribution. It has been reported from Riley county by Root and Hoffman (1937) and from the Arkansas White-Red river basin (Anonymous, 1955a).

Culicoides variipennis albertensis Wirth and Jones

Culicoides variipennis albertensis Wirth and Jones, U.S.D.A. Tech. Bull. No. 1170, 1957.

Recognition Characters. The wings are dark brown with dull grayish white markings and are relatively large in size, 1.4-1.9 mm in length. The over-all color is rather light: the mesonotum is pale and whitish gray; the scutellum is blackish on the median one-third and the sides broadly yellowish.

Bionomics. Wirth and Jones (1957) report that the larvae are probably found along the margins of alkaline pools.

Distribution. It has been reported from Colorado, Montana, Nebraska, Oklahoma and South Dakota (Wirth and Jones, 1957).

Kansas Distribution. It ie reported from Stafford county (Wirth and Jones, 1957), and from Dickinson and Ellsworth countiee (KSC).

Culicoides variipennie auetralie Wirth and Jones

Culicoidee variipennie australie Wirth and Jones, U.S.D.A. Tech. Bull. No. 1170, 1957.

Recognition Characters. It hae a moderately large wing, 1.3-1.9 mm, and ie moderately dark in color. The meeonotum ie light gray and the scutellum is broadly dark brown in the middle and yellowish on the sides. The wing ie dark brown and has dull grayish white markinge about equal in prominenoe and is moderately large, 1.3-1.9 mm.

Bionomice. Wirth and Jonee (1957) report that the larvae probably occur in a ealine environment.

Dietribution. It has been reported to ocour in Louieiana, Miesouri, Oklahoma, South Carolina, Texas and Virginia (Wirth and Jonee, 1957).

Kansas Dietribution. It has been reported to oocur in Greenwood ounty by Wirth and Jonee (1957).

Control of Biting Midges

The moet effeotive ontrol is to eliminate the breeding grounds by diking, drainage and general eanitary proceduree. Since permanent control measures are not always practical or feaeible, eome method of chemical control may prove to be more eatisfaotory.

In the summary of chemical control by Foote and Pratt (1954) it is reported that a eolution of five peroent of gamma ieomer of benzene hexachloride in a miecible oil at a dilution of one part to five hundred parts of water gave a eeventy-two percent mortality of the larvae.

Satisfactory control of the adults may be obtained by painting a five percent solution of DDT or a mixture of pyrethrum and a misoible lubricating oil on window screens (Foote and Pratt, 1954). Area control may be obtained for a limited time by using DDT dispensed as a fog or as heat-generated aerosol.

A repellent containing diethyltoluamids has proved satisfactory for up to ten hours, when applied to the skin and/or clothing for personal protection.

SUMMARY

The species of mosquitoes of the subfamily Culicinae (Culicidae), the biting midges of the genus Culicoides (Heleidae), the black flies (Simuliidae) and the horse and deer flies (Tabanidae) known to occur in Kansas, are presented in this study. Recognition characters, bionomics, United States and Kansas distribution and keys to the species and a summary of control measures are given.

The only known serious insect-borne disease in Kansas in recent years is encephalitis. Malaria was a problem many years ago. But it must be realized that when vectors are present and if the proper conditions arise, a disease of epidemic proportions is potentially possible. The medically important mosquitoes which are proved vectors that occur in Kansas are: Anopheles quadrimaculatus, malaria; Aedes aegypti, yellow fever and dengue; Aedes aegypti, Aedes dorsalis, Culex pipiens, Culex tarsalis, Culiseta inornata and Mansonia perturbans, encephalitis. The tabanids, being mechanical transmitters, must be associated with mammalian reservoirs and susceptible hosts; thus, many species can be considered potential vectors

of tularemia, anthrax, equine infectious anemia, and anaplasmoeie. Simulium occidentale, S. venustum and S. jenningsi are known to transmit leucocytozon dieease. Culicoides spp. are the suspected veotor of bluetongue of sheep and fowlpox of poultry.

From the purely pest etandpoint, the biting diptera in Kansas do not present problems comparable to thoee such ae the salt marsh moequitoee along the Atlantio, Pacific and Gulf coasts, the black flies and biting midges of the northern woods, nor the deer flies of the more humid forеets. In Kansas, moequitoes are oommon following heavy rains which produce temporary pools; and biting midges and deer fliee oan be peets, particularly in low and wooded areas adjacent to ponds and etreams.

During the couree of thie study forty-seven epecies of moequitoes among nine genera, eix speciee of black flies among two genera, forty-seven epeciee of horse and deer flies among seven genera, and eight species of biting midgee were found to occur in Kansas.

A block-type key ie preeented for mosquito identifioation in addition to the conventional ocuplet key. It ie of more value inasmuch ae several important characterietice are available for consideration at one time in condeneed form.

Control measuree are presented which are not unique for Kansae, since each Kansas speoies has a counterpart in some other portion of the United States.

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REFERENCES

Anonymous.
Mosq. records from the Missouri river basin states. Survey Section, Communicable Disease Center, Pub. H. Serv., Fed. Sec. Agcy., Kansas City, Mo. 1951. 93 p.

Anonymous.
A guide to the mosquitoes of the Fifth Army area. Fifth Army Area Med. Lab., St. Louis, Mo. 1955. 36 p.

Anonymous.
Report of the Arkansas White-Red Basins Inter-Agency Committee: Part II, Sec. 10, Mosquito Control and Allied Problems. Ark. White-Red Basins Inter-Agency Com., Tulsa, Okla. 1955a.

Anonymous.
Insect and rodent control. Dept. of the Army Tech. Man. TM5-632. Govt. Print. Off. 1956.

Anonymous.
Insecticide recommendations of the entomology research division for the control of insects attacking crops and livestock. U.S.D.A., Ag. Handbook 120. Govt. Print. Off. 1958.

Anonymous.
Public health pesticides. Comm. Dis. Cen., Pub. H. Serv., U. S. Dept. Health, Education and Welfare, Savannah, Ga. 1958a.

Barr, A. R.
The mosquitoes of Minnesota. Univ. of Minn. Ag. Exp. Sta. Tech. Bull. 228. 1958.

Beadle, L. D.
Report of malaria control in war areas. Investigations in Kansas, 1944. Passed Assistant Sanitarian (R) malaria control in war areas, U. S. Pub. H. Serv. (unpub. report). 1944.

Brennan, J. M.
The Pangoniinae of neartic America. Univ. of Kansas Sci. Bull. 22(13). 1935.

Bruce, W. N. and G. B. Decker.
Control of horse flies on cattle. Ill. Nat. Hist. Sur. Div. Biol. Notes 24. 1951.

Bruce, W. N. and G. B. Decker.
Factors affecting the performance of treadle sprayers. Jour. Econ. Ent. 48:167-169. 1955.

Carpenter, S. J.
The mosquitoes of Arkansas. Ark. St. Bd. of Health, Little Rock (rev. ed.). 1941. 87 p.

Carpenter, S. J.
Mosquito studies in military establishments in the Seventh Corps area during 1941. Jour. Econ. Ent. 35:558-561. 1942.

Carpenter, S. J. and W. J. LaCasse.
Mosquitoes of North America. Univ. of Cal. Press. 1955.

Curran, C. H.
The families and genera of North American Diptera. New York:Ballou Press, 1934.

DeMoss, N. A.
The biology of the mosquitoes in Kansas and a key for their identification. M. S. Thesis. Kans. St. Col. 1937.

Dove, W. E., D. G. Hall and J. R. Hull.
The salt marsh sand fly problem. Ann. Ent. Soc. Amer. 25:505-527. 1932.

Dyar, H. G.
The mosquitoes of the United States. Proc. U. S. Nat. Mus. 62:1-119. Govt. Print. Off. 1922.

Dyar, H. G., and R. C. Shannon.
The North American two-winged flies of the family Simuliidae. Proc. U. S. Nat. Mus. 69(10):1-54. Govt. Print. Off. 1927.

Edmunds, L. R., and G. G. Keenar, Jr.
Observations on the biting habits of Culicoides crepuscularis Malloch in western Nebraska, with notes on other species collected in light traps (Diptera, Hsleidae). Mos. News 14(2):82-3. 1954.

Edwards, F. W.
Diptera, Fam. Culicidae. In P. Wytsman, Genera insectorum, Fas. 194. Brussels:V Vesteneuil and L. Desmst, 258 pp.

Emery, W. T.
Morphology and biology of Simulium vittatum and its distribution in Kansas. Kans. Univ. Sci. Bull. 8(9):323-362. 1913.

Fairchild, G. B.
Guide to the insects of Connecticut, Part VI. The Diptera or true flies of Connecticut. Conn. St. Geol. and Nat. Hist. Sur. Bull. 75. 1950.

Fattig, P. W.
The Tabanidae or horseflies and deerflies of Georgia. Emory Univ. Mus. Bull. 4. 1946.

Foote, R. H. and H. D. Pratt.
The Culicoides of eastern United States. Pub. H. Mon. 18. Govt. Pr. Off. 1954.

Gilbert, I. H., K. K. Gouch, and C. N. Smith.
New insect repellent. Soap and Chem. Spec. May 1957.

Hammon, W. McD. and W. C. Reeves.
Laboratory transmission of St. Louis encephalitis virus by three genera of mosquitoes. Jour. Exp. Med. 78:241–253. 1943.

Hammon, W. McD., W. C. Reeves, and G. Sather.
California encephalitis virus, a newly discovered agent. II. Isolation and attempts to identify and characterize the agent. Jour. Immun. 69:493–510. 1952.

Haye, K. L.
A synopsis of the Tabanidae (Diptera) of Michigan. Mus. of Zoo. Univ. of Mich. Misc. Pub. 98. 1956.

Hermes, W. B.
Medical entomology. 4th ed. New York:Macmillan. 1950.

Hill, N. DeM.
Biological and taxonomic observations on the mosquitoes of Kansas. Kansas Acad. Sci. 42:255–265. 1939.

Hill, M. A. and E. W. Roberts.
Investigation into the effects of gammexane on the larvae, pupae and adults of Culicoides impunctatus Goetghebuer and adults of Culicoides obsoletus Meigen. Ann. Trop. Med. and Parasitol. 41:143–163. 1947.

Hoffman, W. A.
A review of the species of Culicoides of North and Central America and the West Indies. Am. J. Hyg. 5:274–301. 1925.

Horsefall, W. R.
Mosquitoes their bionomics and relation to disease. New York:Ronald Press Company. 723 p. 1955.

Howard, L. O.
Notes on the mosquitoes of the United States. U.S.D.A. Bull. 25. 1900.

James, M. T.
The genus Culicoides in northern Colorado. Pan–Pacific Ent. 19: 148–153.

Jenkins, D. W., and S. J. Carpenter.
Ecology of the tree hole breeding mosquitoes of neartic North America. Ecol. Mon. 16:33–48. 1946.

Jenkins, D. W.
Bionomics of Culex tarsalis in relation to western equine encephalomyelitis. Amer. Jour. Trop. Med. 30:909-916. 1950.

Johannsen, O. A.
A generic synopsis of the Ceratopogonidae (Heleidae) of the Americas, a bibliography, and a list of the North American species. Ann. Ent. Soc. 36:763-791. 1943.

King, W. V., G. H. Bradley, and T. E. McNeel.
The mosquitoes of the southeastern states. U.S.D.A. Misc. Pub. Washington. Govt. Print. Off. Feb. 1944.

Lewis, L. F. and C. M. Jones.
The biology of Tabanids in the Yazoo-Mississippi Delta. Jour. Econ. Ent. 48(5):609-610. 1955.

Lungstrom, L. G.
Biological studies on the common pasture mosquito, Culex tarsalis, Coquillett. PhD thesis. K.S.C. 1950.

Lungstrom, L. G.
Biological studies on Culex tarsalis (Diptera Culicidae) in Kansas. Trans. Kans. Acad. Sci. 57:86-96. 1954.

MacCreary, D.
Report on the Tabanidae of Delaware. Univ. of Del. Exp. Sta. Bull. 226. 1940.

Malloch, J. R.
American black flies or buffalo gnats. U. S. D. A, Bur. Ent., Tech. Series 26. Govt. Print. Off. 1914.

Malloch, J. R.
The Chironomidae, or midges, of Illinois with particular reference to the species occurring in the Illinois river. Bull. Ill. Sta. Lab. Nat. Hist. 10:275-543. 1915.

Matheson, R.
The mosquitoes of North America. Springfield, Ill. Charles C. Thomas. 1929.

Matheson, R.
A handbook of the mosquitoes of North America. New York:Comstock, 1944. 314 p.

McNeel, T. E. and F. F. Ferguson.
Mosquito distribution and abundance in the Arkansas White-Red river basins. U. S. Pub. Health Rpts. 69:385-390. 1954.

Middlekauff, W. W.
The horse flies and deer flies of California. Bull. Cal. Ins. Sur. 1(1). 1950.

Nicholson, H. Page, and C. E. Mickel.
The black flies of Minnesota. Univ. Minn. Exp. Sta. Tech. Bull. 192. 1950. 64. p.

Olson, T. A., and H. L. Keegan.
New mosquito distribution records from the Seventh Service Command Area. Jour. Econ. Ent. 37:847-848. 1944a.

Olson, T. A., and H. L. Keegan.
The mosquito collecting program for the Seventh Service Command for 1942-1943. Jour. Econ. Ent. 37:780-785. 1944b.

Overman, Chauncey.
Notes on some mosquitoes of Douglas county. Trans. Kans. Acad. Sci. 24:133-135. 1906.

Owen, W. B.
The mosquitoes of Minnesota, with special reference to their biologies. Univ. of Minn. Ag. Exp. Sta. Tech. Bull. 126. 1937.

Owen, W. B. and R. W. Gerhardt.
The mosquitoes of Wyoming. Univ. Wyom. Pub. Vol. 31(3). 1957.

Philip, C. B.
The Tabanidae of Minnesota. Univ. Minn. Ag. Exp. Sta. Tech. Bull. 80. 1931.

Philip, C. B.
Notes on nearctic Pangoniinae (Diptera, Tabanidae). Proc. Ent. Soc. Wash.43:113-130. 1941.

Philip, C. B.
A catalog of the blood-sucking fly family Tabanidae (horseflies and deerflies) of the nearctic region north of Mexico. The Amer. Midland Naturalist 37:257-324. 1947.

Philip, Cornelius B.
New North American Tabanidae (Diptera). Ann. Ent. Soc. Amer. 47:25-33. 1954.

Philip, C. B.
New North American Tabanidae VIII. Notes on and keys to the genera and species of Pangoniinae exclusive of Chrysops. Separata da Rev. Brasil Entomologie 2:13-16. 1954a.

Price, D. A. and W. T. Hardy.
Isolation of the bluetongue virus from Texas sheep. Culicoides shown to be vector. Amer. Vet. Med. Assoc. Jour. 124:255-258. 1954.

Quarterman, K. D.
The use of insecticides against adult mosquitoes. Mosq. News 17:254-257. 1957.

Rees, D. M.
The mosquitoes of Utah. Bull. Univ. Utah 33(7). 1943.

Root, F. M. and W. A. Hoffman.
The North American species of Culicoides. Amer. Jour. Hyg. 25:150–176. 1937.

Ross, H. H.
The mosquitoes of Illinois. Bull. Ill. Nat. Hist. Surv. 24, Art. 1. 1947.

Rozeboom, L. E.
The mosquitoes of Oklahoma. Okla. Ag. Exp. Sta. Tech. Bull. T-16. 1942.

Sabrosky, C. W.
The occurrance of malaria mosquitoes in southern Michigan. Michigan State College Agr. Expm. Sta. Tech. Bull. 202. 1–50 p. 1946.

Schomberg, O.
Biological notes on Tabanus abactor Philip and equalis Hine. Jour. Econ. Ent. 48:618. 1955.

Schomberg, O. and D. E. Howell.
Larval habitats of Tabanus sulcifrons in Oklahoma. Jour. Econ. Ent. 45:747. 1952.

Schwardt, H. H.
Horseflies of Arkansas. Ark. Agr. Exp. Sta. Bull. 66. 1936.

Smart, John.
The classification of the simuliidae (Diptera). Royal Ent. Soc. of London, Trans. 95:463–532. 1945.

Stage, H. H., C. M. Gjullen, and W. W. Yates.
Mosquitoes of the northwestern states. U.S.D.A. Handbook 46. GPO. 1952.

Stone, A.
The horseflies of the subfamily Tabaninae of the neartic region. U. S. D. A. Misc. Pub. 305. Govt. Printing Office. 1938.

Stains, G.-S., and G. F. Knowlton.
A taxonomic and distributional study of Simuliidae of western United States. Ann. Ent. Soc. Amer. 36:259–280. 1943.

Tashiro, H. and H. H. Schwardt.
Biology of the major species of horseflies of central New York. Jour. Econ. Ent. 42(2):269–272. 1948.

Tashiro, H. and H. H. Schwardt.
Notes on the biology of Tabanus gigantus. Jour. Econ. Ent. 46:681–682. 1953.

Tate, H. D. and D. B. Gates.
The mosquitoes of Nebraska. U. of Neb., Agr. Exp. Sta. Res. Bull. 133. 1944.

Twin, C. R.
A review of studies of blood-sucking flies in northern Canada. Canad. Ent. 84:22-28.

Wirth, Willis W.
The genus Culicoides in Alaska. Ann. Ent. Soc. Amer. 44:75-86. 1951.

Wirth, W. W.
The Heleidae of California. Univ. Calif. Publ. Entomol. 9:95-266. 1952.

Wirth, W. W. and R. H. Jones.
The North American subspecies of Culicoides variipennis (Diptera, Heliidae). U.S.D.A. Tech. Bull. 1170. G.P.O. 1957.

APPENDICES

APPENDIX I

Density, seasonal distribution and importance of the mosquitoes found in Kansas

Genera and species	Importance*	Density*	Seasonal Distribution ****	
Anopheles				
barberi	U	3		
crucians	P	4		June thru Oct.***
franciscanus	U	4		
pseudopunctipennis	P	3		
punctipennis	P	1	June thru Oct.	April. to Nov.***
quadrimaculatus	V	2	July to Sept.	May to Nov.***
walkeri	U	4		
Aedes				
aegypti	V & P	4		
atlanticus	P	4		Mar, to Nov.***
atropalpus	U	4		
canadensis	P	4	June thru July	
cinereus	U	4		May or June***
dorsalis	V & P	3		Apr. to Oct.***
dupreei	U	4		June to Oct.***
flavescens	U	4		May or June***
nigromaculis	P	2	May thru Sept.	
sollicitans	P	4	May thru July	Apr. to Oct.***
spencerii	U	4		
sticticus	P	3		May to Aug.**
stimulans	P	4		June or July***
triseriatus	P	3	May to July	May to Nov.***
trivittatus	P	3	May thru July	May to Nov.***
vexans	P	1	May thru Sept.	
zoosophus	U	4		
Culex				
erraticus	P	4	July	July to Aug.**
peccator	P	4		July thru Sept.**
pipiens	V & P	3	May thru Sept.	May to Nov.
quinquefasciatus	V & P	3	August	
restuans	P	2	May thru Sept.	
salinarius	P	2	May thru Sept.	May thru Aug.**
tarsalis	V & P	1	June thru Oct.	
territans	U	3	May	
Culiseta				
inornata	V & P	1	Mar. thru Sept.	
Mansonia				
perturbans	V & P	4	Aug. thru Sept.	May to Sept.***
Orthopodomyia				
alba	U	4		May to Aug.**
signifera	U	3	June	June to Aug.**

Genera and species	Importance*	Density*	Seasonal Distribution ****
Psorophora			
ciliata	P	3	May to Oct.***
confinnis	P	2	June thru Sept.
cyanescens	P	4	June thru Aug. May to Oct.***
discolor	P	2	May thru Aug.
ferox	P	3	Apr. to Oct.***
horrida	P	3	May to Sept.***
howardii	P	4	May to Sept.***
longipalpus	P	4	
signipennis	P	3	May thru Aug.
Toxorhynchitis			
septentrionalis	U	4	
Uranotaenia			
sapphirina	U	4	July thru Sept.May to Nov.***

* McNeel and Ferguson (1954)
** Olson and Keegan (1944)
*** Anonymous (1955)
**** Light trap and larval collections at Ft. Riley & Ft. Leavenworth, made available by 5th Army Med. Lab., St. Louis, Mo.

V Vector
P Pest
U Unimportant
1 Abundant and widely distributed
2 Abundant and locally distributed
3 Scarce but widely distributed
4 Scarce and locally distributed.

APPENDIX II

BLOCK KEY TO SUBFAMILY CULICINAE FOUND IN KANSAS - ADULT FEMALE

	PALPI	PROBOSCIS	THORAX	SCUTELLUM	WINGS	ABDOMEN
Anophelini	Nearly as long as proboscis.		Slightly arched.	Rounded on posterior margin.	Distinct markings.	No scales or sternites largely bare.
Culicini	Shorter than proboscis.	Slender, flexible, not hooked.	Strongly arched.	Trilobed.		Clothed with broad flat scales.
Toxorhynchitini	One-sixth to two-thirds as long as proboscis.	Rigid basal half and strongly curved downward on distal half.		Evenly rounded.	Scales sparse, short and broad.	Flat scales of metallic luster.

BLOCK KEY TO GENUS *ANOPHELES* FOUND IN KANSAS - ADULT FEMALES

	SCUTUM		SCUTELLUM	ABDOMEN	LEGS	OTHER CHARACTERISTICS
	Integument	Scales				
barberi	Shiny brown	Long dark setae at least half as long as width scutum.	Clothed with dark setae	Integument brown clothed with dark setae.	Entirely dark	Small species. Wing length 3.0 mm; scales slightly broadened uniformly dark.
walkeri	Dark brown to black	Clothed with short golden-brown hairs medially, longer dark setae laterally.	Clothed with golden-brown hairs and long dark setae.	Integument dark brown to black, densely clothed with yellow to brown hairs.	Dark. Femora and tibiae tipped with pale scales.	Medium species. Wing length 4.0-4.5 mm; scales narrow dark, some of scales forming four darker spots more or less distinct. Halter knob usually pale scaled. Palpi with narrow white ring at apex.
quadrimaculatus	Brown to black	Clothed with numerous pale yellow to golden brown hairs, more numerous medially, longer laterally.	Crescent-shaped, clothed with yellow hairs and long dark setae.	Integument dark brown to black, densely clothed with yellowish brown hairs.	Dark. Femora and tibiae tipped with pale scales.	Medium species. Wing length 4.5 mm; scales narrow dark, some of scales forming four rather distinct spots.
crucians	Mottled gray, brown, and black, pair dark gray submedian longitudinal stripes.	Numerous short yellow hairs, few whitish scales on anterior prementary and longer black setae on lateral fossae.	Clothed with yellowish hairs and long brown setae.	Integument dark brown to black, clothed with numerous yellow to dark-brown hairs.	Dark. Femora and tibiae tipped with white.	Medium species. Wing length 4.0 mm; white to yellowish scales, arranged in contrasting lines and spots. Costa dark except for pale spot at extreme tip; vein 6 with 3 spots of dark scales.
punctipennis	Broad median frosted stripe, dark brown laterally.	Frosted stripe clothed with short pale-yellow hairs, lateral areas with larger dark setae.	Clothed with yellow hairs and long brown setae.	Integument dark brown to black, clothed with pale and dark hairs.	Dark. Femora and tibiae tipped with pale scales.	Medium species. Wing length 4.0 mm; scales black and pale yellow in contrasting lines and spots. Costa with a pale spot at outer third opposite tip of subcosta; vein 6 with basal fourth and apical half dark-scaled; veins 3 and 5 dark-scaled.
* *pseudopunctipennis pseudopunctipennis*	Broad median longitudinal frosted stripe, extending the full length of the scutum. Dark brown laterally.	Frosted stripe clothed with narrow yellowish-white scales and pale yellow hairs. Lateral areas with dark brown setae.	Clothed with long brown setae.	Integument brown to black clothed with golden brown hairs.	Dark. Femora and tibiae pale tipped.	Medium species. Wing length 4.0 mm; scales black and pale yellow, arranged on veins in contrasting lines and spots.

* *pseudopunctipennis franciscanus* differs from *pseudopunctipennis pseudopunctipennis* as follows: Terminal segment of the palpi has the apical part dark-scaled; wing cells 2 is entirely dark-scaled except for a subapical white patch on fork 2.1 and a small patch on stem near the cross cells 2-3; vein 4 has stem predominantly dark-scaled.

BLOCK KEY TO THE SPECIES OF THE GENUS AEDES IN KANSAS

SPECIES	SCUTUM Integument	Scales	ABDOMINAL TERGITES	LEGS	HIND TARSI	OTHER CHARACTERISTICS
dorsalis	Dark	Medium longitudinal stripe of brown scales. Remainder yellowish-white.	1st-Medium patch white scales. Others dark with transverse segmental bands of white scale and a medium dorsal stripe of white scales.	Femora and tibia yellowish-white scaled speckled with dark scales.	Basal & apical white rings 1-3; 4 has basal white ring with few at apex; 5 white.	Wing length 4.0-4.5 mm; narrow dark brown and white intermixed. Knee spots white. Proboscis is dark, speckled with pale scales basal part.
atropalpus	Black	Broad medium stripe dark bronze-brown. Yellow-white or golden anterior submedially and laterally.	1st-Dark few white scales intermixed. Others dark with basal white bands.	Femora-1st dark posterior surface pale; others pale basal half dark distal half. Tibia-Dark. Tipped white basal & apical.	Basal & apical rings 1-4, 5 almost all white.	Wing length 3.0-3.5 mm; scales narrow dark, white base of costa.
canadensis canadensis	Reddish brown.	Golden brown pattern anterior & lateral margins. May have posterior half stripes of pale scales.	1st-Medium patch dark scales sprinkled with white. Others dark with narrow basal white bands (not always). 7th and sometimes 6th segment white scaled.	Femora-Dark. Posterior surface pale. Tibia-Dark, tipped white basal & apical. Posterior surface streaked with pale scales.	Broad basal white rings 1-4, 5 white.	Wing length 3.2-4.0 mm; scales narrow dark. Front and middle tarsi white rings segments 1-3. White knee spots.
sollicitans	Black	Golden to golden-brown scales dorsally. Dark bronze-brown laterally.	1st-Medium patch yellowish-white scales. Others dark, white laterally, and pale yellow basal and medially.	Femora and tibia dark, speckled with pale scales posterior surface.	Segment 1 ringed white at base, yellow at middle. Seg. 2-4 broad white basal rings. Seg. 5 white.	Wing length 3.5-4.5 mm; scales broad mixed white and brown. White knee spots. Proboscis dark scaled with white ring near middle.
nigromaculis	Dark	Broad medium stripe golden-brown scales. Remainder varying shades yellow scales.	1st- medium patch yellowish scales. Remaining yellowish scales basally laterally, surrounding large patches dark scales.	Femora and tibia dark, speckled with pale scales. Posterior surface pale.	Broad basal white bands.	Wing length 3.2-4.2 mm; scales are narrow and dark sprinkled with pale scales. Proboscis dark scaled with white ring near middle.
aegypti	Dark brown	Pale lyre-shaped pattern on dorsum. Dark bronze-brown.	Narrow basal white bands. Silver-white basal patches laterally.	Femora-Dark. Pale posterior surface basal ½. Middle white line base to tip.	Broad basal white rings 1-4, 5 white.	Wing length 2.5-3.0 mm; scales narrow dark. Knee spots white.

zacsephus	Dark brown	Anterior half silver scaled and a median golden-brown stripe. Posterior half dark brown with silver scales bordering prescutellar space.	1st-median patch dark scales. Remaining tergites bronze-brown with narrow basal cream-white bands and silver-white lateral patches.	Hind femora pale scaled all aspects basal half; distal half brownish black. Middle and front femora dark with pale scales on posterior surface of basal half. Knee spots white. Tibiae dark, narrowly marked white basally.	Dark with broad basal white bands on segments 1-4.	Wing length 3.0-3.5 mm; scales narrow dark except for patch of white scales on base of costa, subcosta and vein 1. Middle and front tarsi dark with basal white bands on segments 1-3.
vexans	Brown	Golden brown	1st-dark and pale scales intermixed. Median area II-IV dark with basal white band and basolateral white patches. White scales apical margin last three segments.	Femora dark with scattered pale scales. Knee spots white. Tibia dark. Pale posterior surface tibia and femora.	Dark with narrow basal white rings on all segments.	Wing length 3.5-4.0 mm; scales narrow and dark. Front and middle tarsi similarly marked as hind tarsi, but white rings on segment 4 and 5 greatly reduced or absent.
flavescens	Black	Yellowish to light brown scales. Broad medium stripe dark brown scales.	1st-Medium patch dull yellowish scales. Remaining entirely clothed with dull yellow scales.	Famora and tibia brown with yellowish scales intermixed. Pale on posterior surface.		Wing length 5.5-6.0 mm; scales yellow and brown intermixed. Tarsal segments 2-4 front and 2-5 middle have broad basal yellowish-white rings. Large yellowish species. Proboscis dark brown with scattered yellowish scales.
stimulans	Black	Yellowish-white to light brown. Broad brown medium longitudinal stripe.	1st-medium patch white scales. Others have broad basal band white to pale yellow scales.	Femora and tibia have intermixed dark and white scales with pale posterior surface.		Wing length 4.3-4.8 mm; scales brown and white intermixed. Proboscis dark sprinkled with white scales. Tarsal segments 1-3 front, 1-4 middle have basal white ring remaining dark.
triseriatus	Brown to black		Wide medium stripe, dark brown scales. White scaled laterally.	Front and middle femora black. Hind femora yellowish white basal half to two-thirds. Tibia dark.	Dark	Wing length 3.5-4.0 mm; scales dark. White knee spots.

dupreei	Dark brown	Longitudinal stripe silver-white scales. Remainder bronze-brown.	1st-Dark with mixed pale scales. Others dark with white basolateral patches.	Coxa of foreleg white scaled. Posterior surface femora pale scaled. Remainder dark.	1st segment has pale scales on posterior surface.	Wing length 2.5 mm; narrow brown scales. Small species.
atlanticus	Dark brown	Dark bronze-brown. Silver-white to pale medium stripe entire length.	Dark scaled. Basal triangular patches white scales laterally.	Femora-Dark except pale posterior surface. Tibia-Dark.	Dark	Wing length 3.0-3.6 mm; scales narrow dark.
trivittatus	Dark brown	Pair of narrow stripes of white to yellowish-white scales separated by a median brown stripe. Bronze-brown scales on sides.	1st-dark. Others dark with basolateral white patches. Often small median white basal patches.	Dark scaled posterior surface of femora and tibia pale.	1st segment pale.	Wing length 3.5-4.0 mm; scales dark brown.
spencerii	Black	Yellowish white. Broad medium longitudinal stripe brown scales may be divided by pale scales.	1st-white scaled. Remaining medium white stripe and apical & basal white bands or entirely white.	Femora yellowish and brown scales intermixed, posterior surface pale, dark apically. Tibia pale scaled posterior surface dark apically.		Wing length 3.8-4.1 mm; scales pale and veins dark. Tarsi partly dark scaled, pale on posterior surface, distal segments are darker.
cinereus	Brown	Evenly clothed reddish-brown.	1st-Medium patch brown scales. Others brown.	Femora and tibia dark with posterior surface pale.	Dark	Wing length 3.2-3.8 mm; scales narrow brown. Knee spots pale. Medium to small species.
sticticus	Dark brown to black.	Yellowish white. 2 medium stripes golden brown scales.	1st-medium patch white scaled. Others dark with narrow basal white band, which broadens into basal triangular patch.	1st & 2nd femora dark, speckled with pale scales. Posterior surface pale. 3rd femora mostly pale scaled dark apically. Tibia dark.		Wing length 3.2-4.0 mm; scales dark. Tarsi dark, (may be speckled with pale scales).

BLOCK KEY TO *CULEX* IN KANSAS - ADULT FEMALE

	PROBOSCIS	SCUTUM Integument	SCUTUM Scales	ABDOMINAL TERGITES	LEGS	OTHER CHARACTERISTICS
erraticus	Dark	Dark brown	Golden brown	Narrow white basal bands.	Posterior surface of femora pale and pale knee spots remaining dark.	Wing length 2.5-3.0 mm; scales dark. Scutellum has golden scales and brown setae on lobes.
peccator	Dark	Dark brown	Brown	Dark with small basolateral patches of white scales.	Posterior surface femora and knee spots are pale; remaining dark.	Wing length 2.5 mm; scales dark. Scutellum has brown scales and brown setae.
tarsalis	Dark with broad median white band.	Brown to black.	Golden brown dorsally; narrowly margined anteriorly and laterally with white scales.	1st median patch of dark scales with few pale scales intermixed; 2nd median basal triangular patch pale scales; remaining prominent basal bands of white scales. Terminal segments have apical pale scales.	Posterior surface femora and tibiae yellowish white scaled. Narrow line pale scales on anterior surface of femora and tibiae. Wide basal and apical white bands on tarsi.	Wing length 4.0-4.4 mm; scales dark few white on the costa and subcosta. Scutellum has whitish scales and brown setae on lobes.
territans	Dark	Light brown.	Light brown; anterior and lateral margins paler.	1st median patch dark scales; remaining narrow apical bands white scales.	Posterior surface of femora and tibiae pale scaled; remaining dark.	Wing length 3.0-3.9 mm; dark scaled. Scutellum has greyish scales and brown setae on lobes.
salinarius	Dark; paler on ventral side.	Brown.	Golden brown; paler on anterior and lateral margin.	1st medium patch of dark scales; remaining have broad basal bands of dingy yellow scales; broadly joined to basolateral patches; 7-8 tergites almost all pale scaled.	Posterior surface femora and tibiae pale scaled; pale knee spots remaining scales dark.	Wing length 3.5-4.0 mm; dark scaled. Scutellum has yellowish white to light golden scales and brown setae on lobes.
restuans	Dark with some pale scales on ventral surface.	Light to reddish brown.	Golden brown.	1st median patch of dark scales; remaining dark scaled with pale basal bands broadly joins lateral patches.	Posterior surface femora and tibiae pale scaled; pale knee spots remaining scales dark.	Wing length 4.0-4.4 mm; dark scaled. Scutellum has narrow golden scales and brown setae on lobes.
quinquefasciatus[*]						
pipiens	Dark.	Brown.	Narrow golden brown.	1st med patch of dark scales; remaining have pale basal bands broadly rounded on posterior margin and narrow at junction of sides.	Posterior surface femora and tibiae pale scaled; pale knee spots remaining scales dark.	Wing length 3.5-4.0 mm; dark scaled. Scutellum has narrow golden scales and brown setae on lobes.

* *quinquefasciatus* and *pipiens* are similar except at the junction of the basal bands and the basolateral patches, *pipiens* is more broadly joined. Intermediate forms are found.

BLOCK KEY TO *PSOROPHORA* FOUND IN KANSAS - ADULT FEMALE

	PROBOSCIS	THORAX	ABDOMEN		OTHER CHARACTERISTICS
confinnis	Dark and a wide yellowish white median band.	Scutue clothed brown to blackish scales except for lavandar tinted white scales on prescutallar space.	lst tergite median patch of grayish white scales; remaining tergites dark with white to pale yellow scaled apical markings triangular in shape on II and III, and divided into paired submedian patches on IV-VII.		Femora dark brown to black speckled with white scales, posterior surface largely pale scaled. Tibias black with numerous white scaled spots on outer surface. Hind tarsi has a bread basal wing on each segment; ring absent on front and middle tarsi segment 4 and 5. Wing length 4.0-4.5 mm; scales speckled dark brown and white.
signipennis	Dark scaled basally and apically and a wide whitish yellow median band.	Scutum clothed with golden brown scales, becoming pale yellow on sides.	lst tergite median area white scaled; remaining tergites primarily white scaled and speckled with dark scales.		Femora dark speckled with pale scales and pale on posterior surface. Tibiae dark speckled with pale scalaa. Hind tarsi with segment 1 pale scaled sprinkled with dark scales, dark ringed subapically and basally. Wing length 3.2-4.0 mm; scales intarsixad white and dark brown to black.
discolor	Dark except for wide median pale yellow band.	Scutum clothed with pale yellow to golden brown scales.	lst tergite grayish white scaled on median area; remaining tergites almost antiraly covered with grayish white to pale yellow scales.		Femora intarsixed with dark brown and pale scalaa, posterior surface pale. Tibiae pale speckled with dark scales. Hind tarsi with segment 1 pale; 2-5 variable usually pale basal half, dark apical half. Wing length 3.0-3.7; scales dark brown and pale arranged in dafinita pattern.
howardii	Brown.	Scutum has a narrow median stripa, dark scales and black satae; narrow submedian stripa of dark scalaa; and a large lateral area of pale scalae on aithar side.	Bread median patch white scales.	Blue black scaled dorsally.	Femora yellow scaled, speckled with dark. Tibiae clothed with yellow and purple scales. Tarsi primarily dark scaled blanded with yellow and purplish reflection. Second and oftan first with pale basal ring. Wing length 6.0-6.5 mm; scales dark brown.
ciliata	Dark brown on basal half; yellow and speckled distal half.	Pale golden narrow median stripe; narrow nude submedian stripe on aithar side; bread appressed pale yellow to white on sides.	lst tergite Median patch grayish white scales.	Pale yellow to brown scalad.	Femora yellow scaled, speckled with dark on basal two-thirds, apical part densely with long dark scales. Tibiae with long scales axcapt for narrow basal ring of yellow. Front and middle tarsi segments 1 to 3 pale basally, dark apically segments 4 and 5 dark. Hind tarsi basal ring pale scales. Wing length 6.0-6.5 mm; scales brown few pale on coata and subcosta.

PSOROPHORA (Continued)

	PROBOSCIS	THORAX	ABDOMEN	OTHER CHARACTERISTICS
cyaneacens	Dark	Scutum clothed with elaed scales, mostly pale yellow to gold or golden brown; lateral areas gold to pale yellow or white.	1st tergite largely white scaled; tergites II to VI black scaled and with apical submedian triangular patches golden yellow scales; tergite VII dark scaled.	Femora yellow scaled and is speckled with dark scales. Tibiae and tarsi entirely dark. Wing length 4.0-4.3 mm; scales dark brown.
ferox	Dark	Scutum clothed with dark brown and golden yellow or yellowish white scale not in a definite pattern.	1st tergite with median patch of dark scales; remaining tergites dark scaled.	Femora is dark and is pale on posterior surface. Tibiae and tarsi of front and middle legs dark scaled; segments 4 and 5 of hind tarsi white scaled. Wing length 3.7-4.0 mm; scales dark.
horrida	Dark	Scutum has a broad median stripe of dark brown scales which is bordered laterally with grayish white to pale yellow scales.	1st tergite pale scaled; remaining tergites are dark purplish on dorsum.	Front and middle femora dark purplish scaled with the posterior surface being pale. Hind femur basal half pale and dark apically. Front and middle tarsi and tibiae dark scaled. Segments 4 and 5 of hind tarsi white scaled. Wing length 3.8-4.0 mm; scales dark.
longipalpis	Dark	Scutum has a broad median stripe, dark brown scales bounded laterally by white to yellowish scales.	1st tergite with yellowish white scales; remaining tergites violet scaled dorsally and have small apical patches yellowish scales laterally on IV to VI or VII.	Front and middle femora dark and posterior surface pale. Tibiae and tarsi of front and middle legs dark. Segments 4 and 5 of hind tarsus white. Wing length about 4.3 mm; scales dark.

BITING DIPTERA OF MEDICAL IMPORTANCE IN KANSAS

by

WILLIAM WOOD YOUNG

B. S., Kansas State College
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The species of mosquitoes of the subfamily Culicinae (Culicidae), the biting midges of the genus Culicoides (Heleidae), the black flies (Simuliidae) and the horse and deer flies (Tabanidae) known to occur in Kansas, are presented in this study. Recognition characters, bionomics, United States and Kansas distribution and keys to the species and a summary of control measures are given.

The only known serious insect-borne disease in Kansas in recent years is encephalitis. Malaria was a problem many years ago. But it must be realized that when vectors are present and if the proper conditions arise, a disease of epidemic proportions is potentially possible. The medically important mosquitoes which are proved vectors that occur in Kansas are: Anopheles quadrimaculatus, malaria; Aedes aegypti, yellow fever and dengue; Aedes aegypti, Aedes dorsalis, Culex pipiens, Culex tarsalis, Culiseta inornata and Mansonia perturbans, encephalitis. The tabanids, being mechanical transmitters, must be associated with mammalian reservoirs and susceptible hosts; thus, many species can be considered potential vectors of tularemia, anthrax, equine infectious anemia, and anaplasmosis. Simulium occidentale, S. venustum and S. jenningsi are known to transmit leucocytozon disease. Culicoides spp. are the suspected vector of bluetongue of sheep and fowlpox of poultry.

From the purely pest standpoint, the biting diptera in Kansas do not present problems comparable to those such as the salt marsh mosquitoes along the Atlantic, Pacific and Gulf coasts, the black flies and biting midges of the northern woods, nor the deer flies of the more humid forests. In Kansas, mosquitoes are common following heavy rains which produce temporary pools; and biting midges and deer flies can be pests,

particularly in low and wooded areas adjacent to ponds and streams.

During the course of this study forty-seven species of mosquitoes among nine genera, six species of black flies among two genera, forty-seven species of horse and deer flies among seven genera, and eight species of biting midges were found to occur in Kansas.

A block-type key is presented for mosquito identification in addition to the conventional couplet key. It is of more value inasmuch as several important characteristics are available for consideration at one time in condensed form.

Control measures are presented which are not unique for Kansas, since each Kansas species has a counterpart in some other portion of the United States.